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Vol 30. 505 PEARL STREET, NEW YORK. No. 27.

Index to Advertisers and Classified Index Following Reading Matter.

P&W

THE NEW OPEN

TURRET LATHE

WITH CROSS-SLIDING TURRET.

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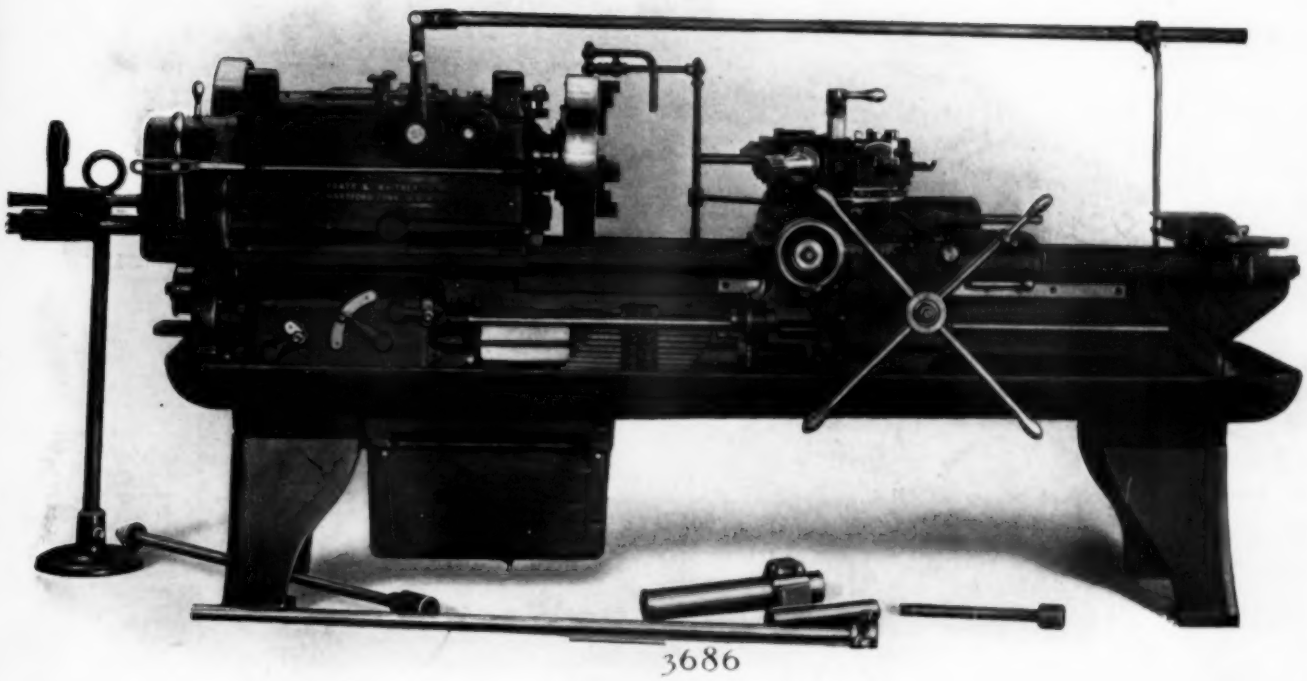

3686

New 2½ x 26 Pratt & Whitney Open Turret Lathe with Cross-Sliding Turret

A universal machine suitable for a great variety of work from the bar and on forgings and castings.

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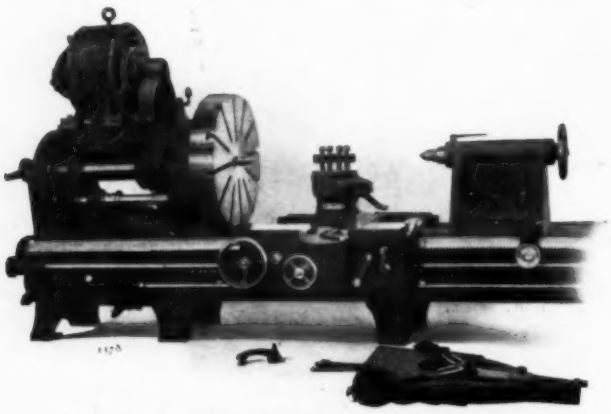

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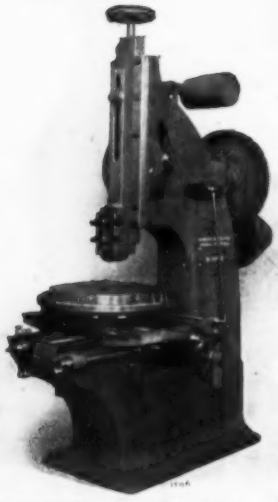
Lathes in all sizes from the little Bench Lathe To the massive 125 inch Crank Shaft Lathe.



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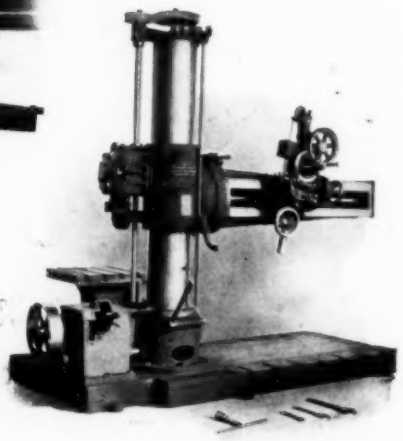

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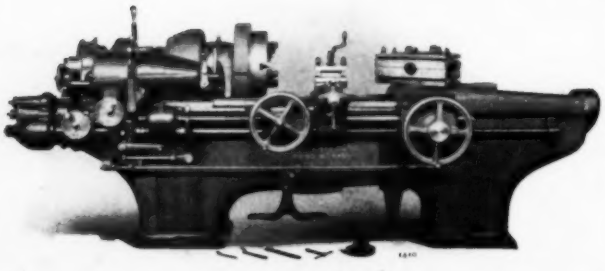

21-Inch Pond Rigid Turret Lathe, two sizes.

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60-ton and 40-ton Niles Cranes, 75-ft. Span, Former with 10-ton Auxiliary Hoist—Two 10-ton Niles 3-Motor Wall Cranes, 25-ft. Arms. Reading Iron Co., Reading, Pa.

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Something New in the Measurement of Power

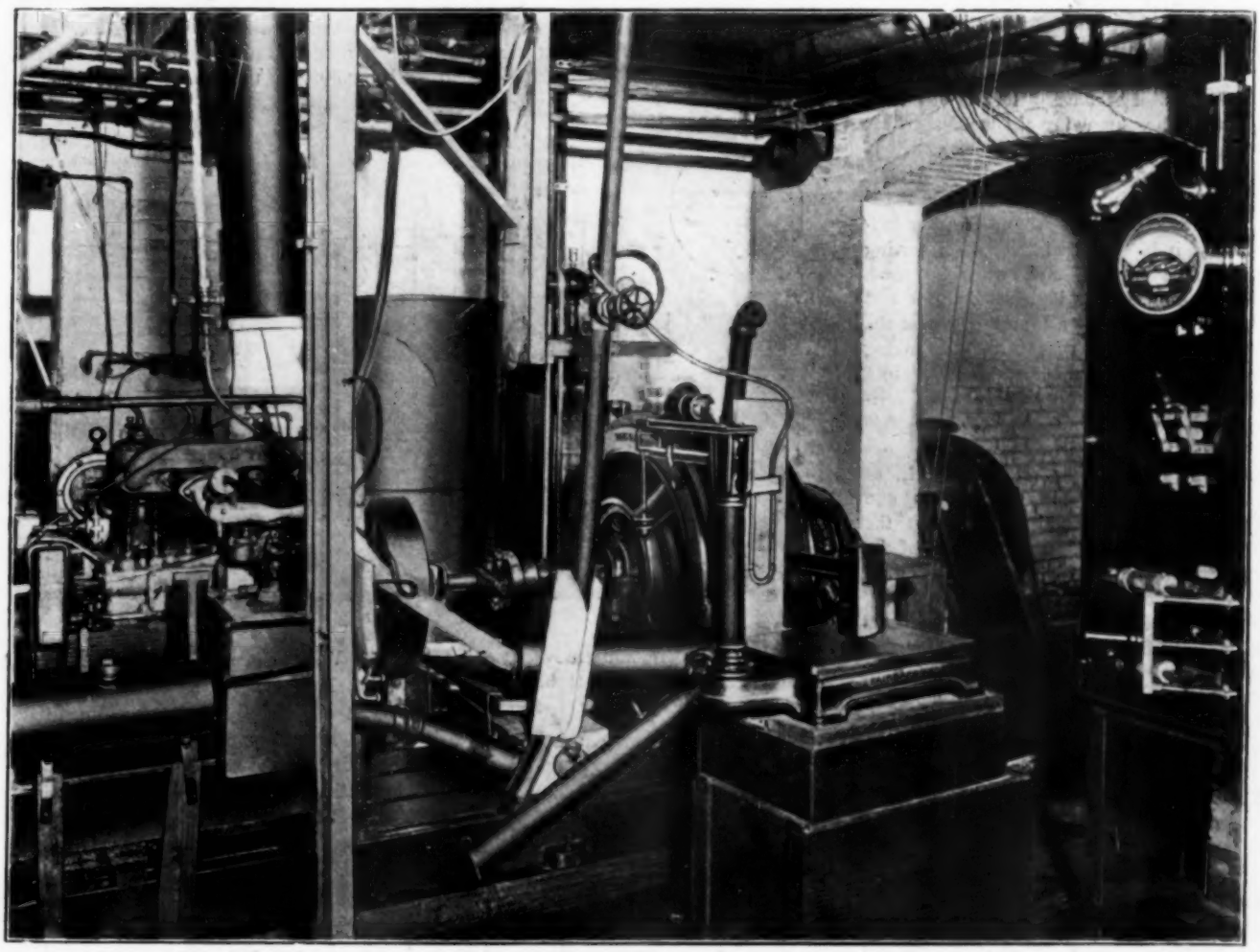
Convenience of the Electric Motor as a Source of Power Retained with Positive Mechanical Measurement of the Power Consumed

EDITORIAL CORRESPONDENCE

Since the electric motor came into general use as a source of power, it has also been largely used in power measurements, the readings of the ammeter and voltmeter being converted into mechanical terms, with a suitable correction to provide for the losses of the motor. While, of course, much useful information has been obtained in this manner, there is nevertheless little to recommend it except its convenience. The efficiency of a motor varies with every change of conditions, giving rise to a corresponding variation in the correction factor to be applied, and, inasmuch as the conditions under which these correction factors were originally determined cannot always be repeated, there is a considerable factor of uncertainty in the final results. The method is not only roundabout but the results are subject to more or less and often considerable doubt. While available for rough determinations it cannot be considered satisfactory for accurate work.

The accompanying illustration is from a photograph of a piece of apparatus at the laboratory of the Henry Souther Engineering Company, of Hartford, Conn., which, while retaining the conveniences of the electric motor as a source of power in power tests, eliminates all of these uncertainties and gives the power measurements directly without conversion from electrical to mechanical terms, and without the use of any correction factor whatever. Moreover, the apparatus may be used to perform the function of a Prony brake, and thus measure the output of a machine under test, or it may be used as a motor, and thus determine the input of power. It thus possesses a greater range of application and of flexibility than any other power-measuring device with which I am acquainted, and its internal losses are probably smaller than those of any other power-measuring apparatus. It is scarcely less than an ideal piece of apparatus.

The photograph is far from being all that might be desired, but this is due to the location of the apparatus in a crowded basement, giving very little opportunity for choice in the location of the camera. A few words of explanation will, however, make the arrangement clear.



A NEW ARRANGEMENT OF THE ELECTRIC MOTOR AS A DYNAMOMETER

The apparatus consists of a 35-kw. dynamo, which is lifted bodily an inch or two from its bed plate and supported in that position by two cast-iron vertical brackets—one at each end of the shaft—between which and the outside casings of the main journals ball bearings are fitted in which the entire field frame is free to

swing. Surrounding and secured to the field ring is a bar of T iron with its free end projecting horizontally, the extreme end having bolted to it a round-bottom block of wood, which rests upon a platform scale reading to quarter ounces.

Action and reaction being equal, it follows that the torque of the armature produces an equal torque in the opposite direction in the field ring, which torque is transmitted through the arm to the platform scale where it is measured. The speed being taken with a revolution counter, the figures are complete from which to obtain the exact mechanical power. Belted to the armature shaft and supported on a wooden bracket above the machine, is a tachometer, by which the speed is adjusted, although for accurate determinations the speed is taken with a revolution counter as mentioned above.

By a suitable switchboard device the dynamo may be converted from a generator into a motor, and *vice versa*. In the former case it becomes a sort of electrical Prony brake, supplying the necessary resistance to any source of power which is to be measured, and in the latter case it becomes a motor supplying the power for any purpose desired. At the Souther laboratory, it is employed chiefly for testing automobile engines, and, when so used, the dynamo is used both as a motor and as a generator. As a motor it brings the engine up to speed without hand cranking when, as soon as the engine comes into operation the throwing of the switch converts the dynamo into a generator, supplying the necessary resistance to the engine under test. The switchboard is, of course, supplied with an ammeter and voltmeter in the usual manner, but the object of these is only to keep track of the current, in order to insure that it does not exceed the capacity of the dynamo.

It will be seen that the only factors which interfere with the absolute correctness of the apparatus are the friction of the ball bearings and of the platform scale, both of which are obviously negligible. F. A. H.

Importation of Swiss Clocks and Music Boxes

The Swiss exports of clocks, watches, and parts of, to the United States last year was the largest in the past 20 years, their value being $2,469,516, against $2,261,519 in 1905. This trade, which amounted to $1,671,028 in 1887, declined in 1895 to $1,000,000, continuing the retrogression until 1898, when the shipments of time-pieces to America amounted to but $746,240. Since that time the trade has been rapidly recovered. Music boxes from Switzerland no longer find the wide sale as formerly, the sales in 1887 having amounted to $235,415 and in 1890 to $300,708. There has since been a continuous drop, the exports amounting to but $52,174 in 1905 and $43,151 in 1906.

Drilling Jigs and a Counterbore

By W. Maddison

The accompanying illustrations show two drilling jigs and a counterbore used in the manufacture of telephone parts. The stock used is 7/16-inch square bronze, cut to a little over finish size and lapped to an easy fit in the jig, Figs. 5 and 6. In this jig the three transverse holes and the longitudinal holes are drilled.

The jig is shown in position for drilling the longitudinal hole, the jig being laid over on to the legs *H* and the edge of the base *B* for drilling the transverse holes.

The body of the jig *A* is machine steel, grooved out for the stock and bored for the hard-steel bushes *K*. Affixed to the body is a base plate *B*, which carries a stop pin *I*, against which the stock is located. Fastened to the top of the body is a hardened tool-steel plate threaded for the screw bush *F* and grooved one end, through which a hard-steel hinge pin *E* passes.

Holding the Work with a Wedge

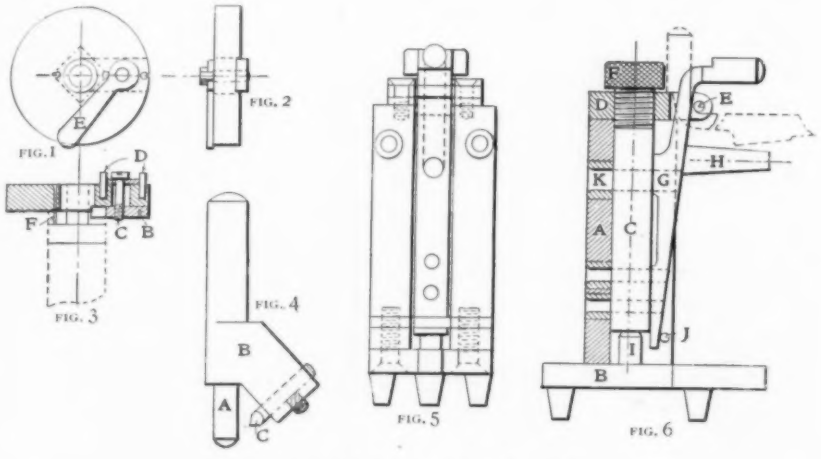
The principal feature of this jig is the hinged wedge, which overcomes the trouble usually attendant in jigs with loose wedge fixing pieces. The wedge *G* is shaped at the handle end to allow it to move through 90 degrees without falling out, as shown by dotted lines. Across the groove at the bottom of the jig is a hard-steel pin *J*, against which the wedge grips. In drilling, this wedge takes the thrust when the jig is horizontal. To remove the stock the wedge is simply pulled up and the screw bush given a turn, when the stock is released.

After this operation the stock is held in a vertical rig and counterbored with the counterbore shown in Fig. 4. The pilot of this fits the longitudinal hole previously drilled. After counterboring to a gaged hight from the bottom of the stock, the cutter *C* is replaced by a cutter which cuts the circular top to gage length and also chamfers the edge to aid threading afterward.

Drilling Small Hole in End

The operation of drilling the stop-pin hole *F* is performed in the jig, Figs. 1, 2 and 3. This jig consists of a circular steel plate bored to fit over the circular part of the stock formed by counterboring, as shown dotted in Fig. 3, and grooved for the slide *B*, which has a 90-degree *V* in one end, which engages with one corner of the square part of the stock.

This slide is actuated by the eccentric plate *E* through the screw *C*. Fitted in the top of the jig are two pins *D*, between which the circular part of the eccentric plate lies; therefore, as the outside of the eccentric cannot change its position when the lever is moved, the hole does. This carries the screw *C* and the slide, grips the corner of the stock and pulls it true diagonally with the drill hole in the jig.



DRILLING JIGS FOR TELEPHONE WORK

The Wilkes-Barre shops of the Lehigh Valley Railroad have turned out the longest all-steel freight car yet manufactured. It is to be exclusively used for the transportation of the large guns made at the Bethlehem works. The car measures 100 feet long, has four trucks, with 32 wheels, and has a capacity of 250,000 pounds.

The Krupp establishments employ at present some 53,000 workmen and 5000 engineers and officials. Of this total of 58,000 persons, 40,000 persons are employed at the steel works and coal mines at Essen, 4000 in the iron mines, 4000 at Rheinhausen, 4000 at Magdeburg, 5000 at the Germania shipyard at Kiel, and 1000 at the steel works at Armen. Among the leading specialties of the firm are guns, armor plates, rifles, shells, boilers, rails, axles, tires, propellers, tubes, etc.—*Mechanical World.*

Machine Tools in a Concrete Machine Shop

Arrangement of Departments and Methods of Setting Machine Tools in the Concrete Buildings of the United Shoe Machinery Company

BY L. P. ALFORD

It is the purpose of this article to treat only of the general manufacturing departments. The plant contains many special departments making a particular product devoted to some feature of the boot and shoe industry; but these will not be considered, as they are not of general interest. However, the general manufacturing departments will be treated in considerable detail. Several views of this plant have been shown on pages 723 to 729, inclusive.

The departments which we are to consider are located entirely in buildings *A* and *B*. These are the two main buildings of the plant. Each is 820 feet long, 60 feet wide, and four stories in hight.

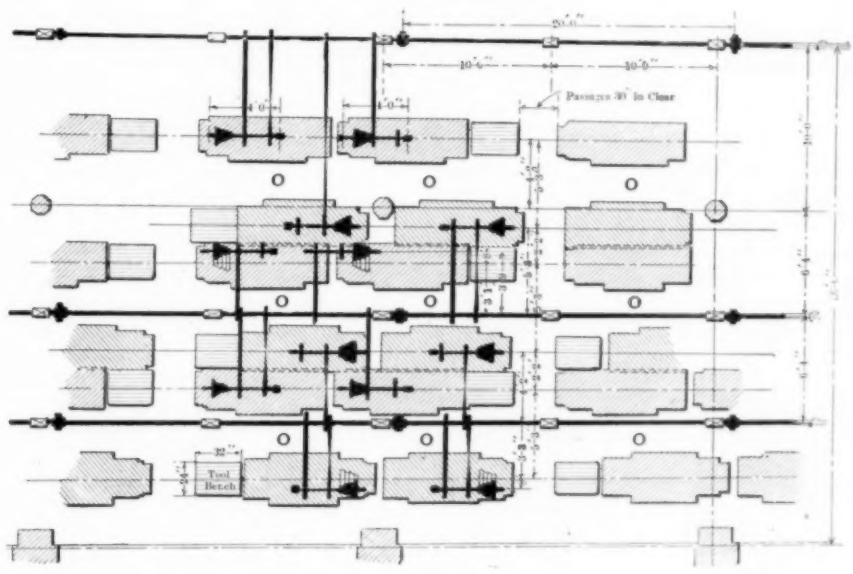


FIG. 1. ENGINE LATHES

Departments on the First Floor Level

On the first or ground floor level of building *A* is the finished-stock room, a room devoted to the storage of finished parts that are awaiting orders from the setting-up floor or that are awaiting shipment. This floor was selected for the purpose because it is not quite as desirable for manufacturing as the floors above, and because the nature of the floor permitted any amount of weight to be placed upon it. The loads from such storage are enormous. On the corresponding floor of building *B* is located the hand and automatic screw-machine department and a few connected departments, such as the finishing of screws and secondary operations on screw-machine products.

Departments on the Second Floor Level

The second floor level of building *A* contains at the southern end the general offices, and beyond them the setting-up floor for practically all of the manufactured machines of the plant. The only exception in this particular is that a few of the heaviest machines are set up on the same floor level in building *B*. At the northern end of the floor is the small-tool department. This is equipped to make all kinds of regular and special cutters, reamers, and other small perishable tools. In building *B*, on this floor level, are the heavy machine tools for machining the frames and heavy parts of the entire line of machinery manufactured, with a setting-up floor for some of the heaviest of these machines. Space is also devoted to a special department making a line of cutters used for cutting leather in various shoe-shop operations.

Departments on the Third Floor Level

The third floor level carries the general manufacturing of the entire plant. The southern end of building *A*, directly over the main offices, is devoted to the general drawing room; beyond this we find the general milling-machine department, and beyond that the general drilling department. On the corresponding floor of building *B*, beginning at the southern end, are the grinding department, lathe department, planer department and cam- and gear-cutting departments. On this floor level the major portion of the machine manufacturing of the plant is carried on, and this is the floor level which will interest us mainly throughout this article.

Departments on the Fourth Floor Level

The next floor level is devoted mainly to special work. At the southern end of building *A*, are the inventing rooms, and beyond them the experimental department and tool department. These departments contain the best of machine tools and employ the best of workmen. The corresponding floor level in building *B* has in the southern end the pattern shop, and beyond that several departments devoted to a specialized line of product and not directly connected with the general manufacturing of the plant.

Machine-tool Lay-outs

The scheme of manufacture, as far as the general manufacturing is concerned, is what is known as the *one-shop* plan, that is, as far as possible machine tools of the same kind are grouped together into large departments, and all work for those machines is brought to these departments. It is unnecessary to consider the advantage of this system, as it is a well founded scheme of manufacture. It is to be noted, however, that these departments constituting the general machine manufacturing, that is, the lathe, miller, planer, drill, grinding, cam-cutting and gear-cutting departments, are all on the same floor level. This gives ample facilities for communication between them.

At the time of making the plans for the original plant it was clearly seen that a well worked out method of arranging the machine tools must be developed and adhered to, if these machines were to be set to give the best utility and at the same time to be economical of floor space. A set of drawings was made showing the best arrangement of machine tools for the various sizes and kinds, and the method of grouping them into departments. These drawings also took into consideration the location of countershafts, and the best arrangement of main line shafting.

As group driving had been determined upon either for complete departments or sections of departments, in general, the main line shafting could be arranged for each and every kind of machine tool without reference to any other kind.

These machine-tool lay-outs were typi-

calized, and some are presented in this article. A few general principles were laid down at the outset in connection with the setting of machine tools. They were to be set far enough away from the windows so that a person could walk clear around the floor next to the windows for any purpose necessary. In general no benches were to be built against any side walls, preference being given for cross benches, that is, benches running crosswise of the length of the room. A main aisle 8 feet wide in the clear was to be left throughout the center of each floor. Ample aisles were to be left connecting this main aisle with the window aisle and passing between individual blocks of tools in each of the main groups. Each workman was to be provided with an individual table having a drawer, and space for these individual tables was to be left in connection with the arrangement of the machines. Main line shafting might be placed anywhere with reference to any particular group of machine tools in order to obtain an economical method of driving. In general such lines of shafting were to be arranged so that the belt from the line shaft to the countershaft should be of a reasonable length. Long overhead belts were to be avoided wherever possible. All tools were to be set with reference to economy of floor space, or as the saying goes, they were to be set so that no one would ever want to "close them up." To meet these conditions several plans were made in order to determine the best arrangement.

The accompanying series of cuts show the methods finally determined upon. These are reproduced in considerable detail and have a number of dimensions which show the clearance which is left around the various tools. They also show the main lines of shafting and the belting scheme for the various countershafts. The reader can judge for himself whether or not the original conditions laid down were fulfilled.

It should be noted that the bays of the building are 20 feet on centers, so that an interior column formed an obstacle on each side of the main aisle, each 20 feet in the length of the building. The excellent light, however, permitted the setting of machine tools inside of these two interior rows of posts, this space being practically as valuable for manufacturing purposes as the space in the side spans.

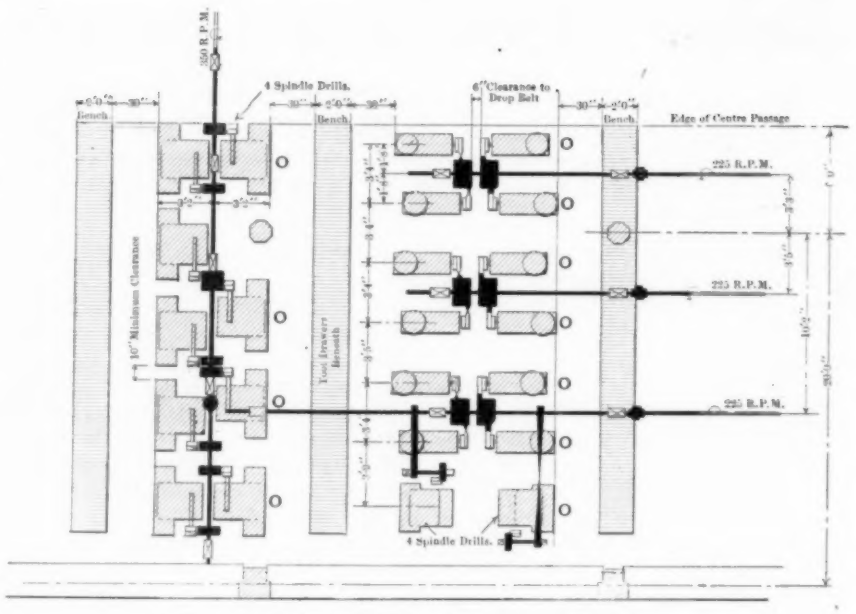


FIG. 4. SMALL UPRIGHT AND SENSITIVE DRILLS

Arrangement of Lathes

In general the cuts need very little explanation. Fig. 1 shows the general lathe lay-out, an arrangement used for 12-, 14- and 20-inch lathes. They are arranged in groups of twelve in parallel rows, with a cross aisle at each end. It will be noticed that an individual table, indicated by a small rectangular area, is provided at intervals. This arrangement supposes that an operator works between each pair of lathes, which are set facing and a little offset. The position of the operator is indicated by a small circle, and this method of indicating is uniform throughout this set of cuts.

Arrangement of Planers

Figs. 2 and 3 show the arrangement of planers, the first that of heavy tools of about 30 inches in size, and the second

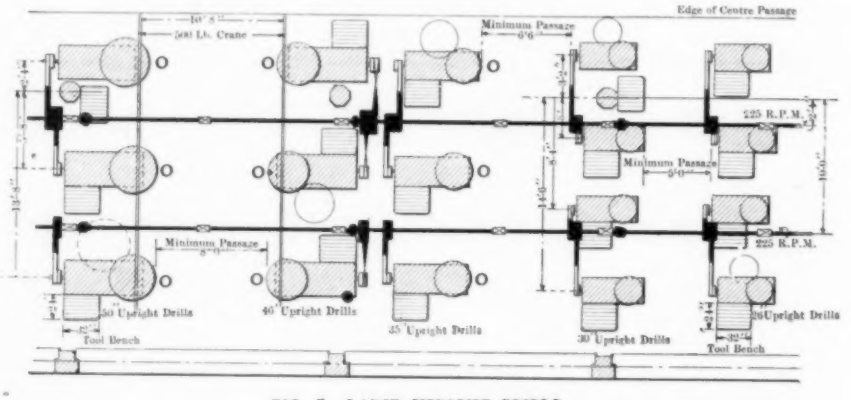


FIG. 5. LARGE UPRIGHT DRILLS

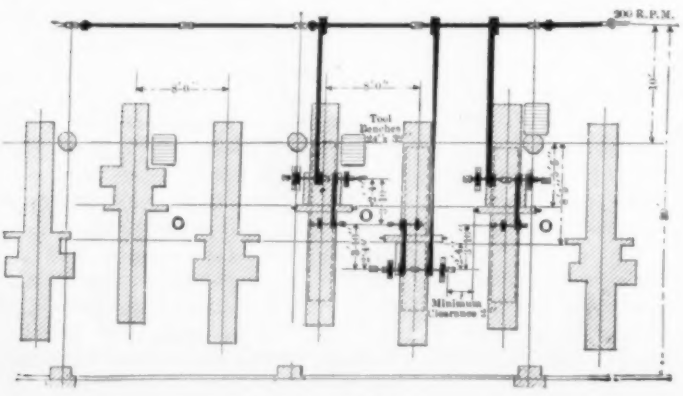


FIG. 2. PLANERS

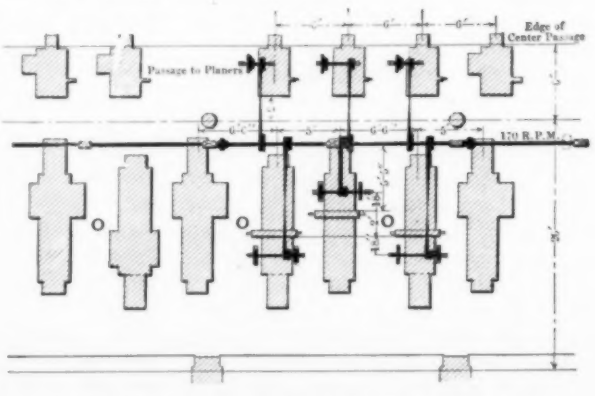


FIG. 3. SMALL PLANERS AND SHAPERS

smaller planers and shapers. The important feature is that the planers are set by the method commonly called "head and tails," that is, the members of each pair face in opposite directions, so that the operator works between his machines. The countershafting and main line shafting scheme is very clearly shown.

Arrangement of Drills

Turning to Figs. 4 and 5, we see the arrangement worked out for large and small upright drills. In Fig. 4 are the smaller uprights placed in parallel rows between cross benches. There is also shown a double row of sensitive spindle drills. In this case the drawers for the workmen's tools were intended to be placed under the bench instead of having the individual benches which have been previously referred to. The bench is also of service for carrying vises used in connection with jig-drilling work. The feature of the shafting arrangement is of interest, four lines being shown in this cut, one of which is a cross shaft. This point of being able to place shafting in any position desired cannot be dwelt upon too strongly as one of the advantages of the group-drive system using electrical transmission of power. Fig. 5 needs no special mention. It shows larger drills. In this case, however, the cross benches are done away with and the individual tool bench is used.

Arrangement of Grinders

In Fig. 6 we have the arrangement of plain and universal grinders for the general grinding department. It presents an easy method of setting plain and universal grinders and handling the troublesome problem of belting. Probably many of us have had our troubles in setting the large and complicated countershafts for grinders. It is impossible to drive belts through, over or under them, and usually one or more belts are in the particular location where we wish to put the grinder counter.

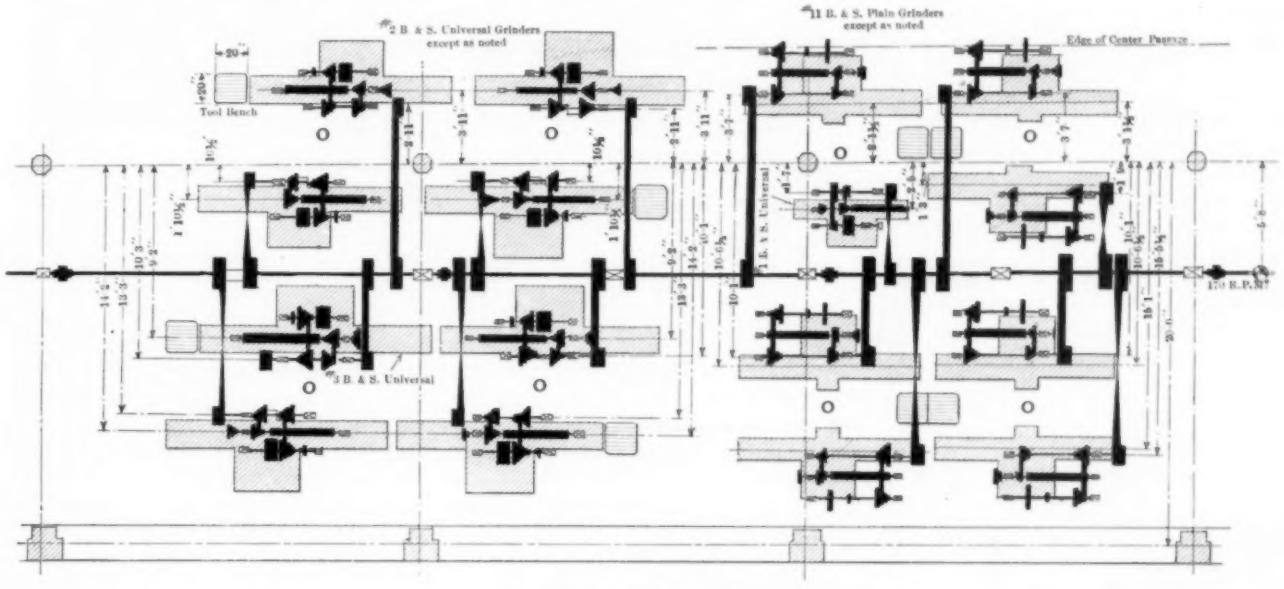


FIG. 6. PLAIN AND UNIVERSAL GRINDERS

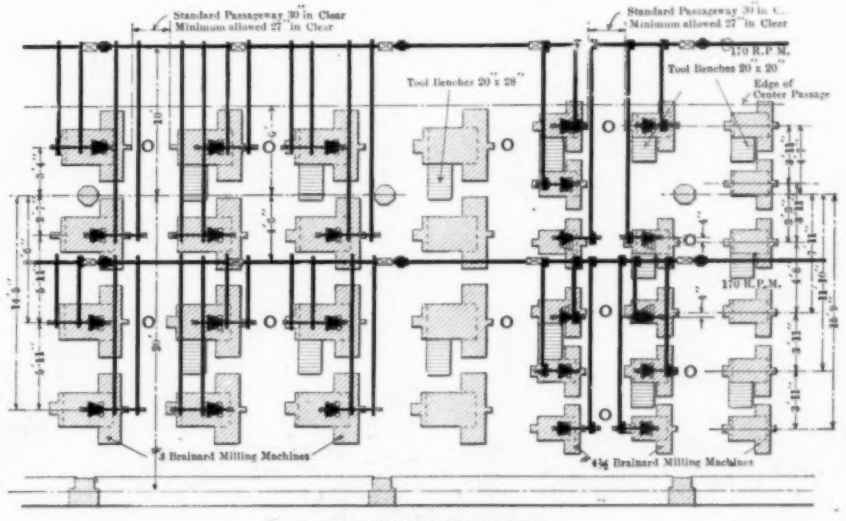

Standard Passageway 30 in Clear
Minimum allowed 27 in Clear
Tool Benches 20 x 28
Tool Benches 20 x 20
Edge of Center Passage
170 R.P.M.
3 Brainard Milling Machines
4½ Brainard Milling Machines

FIG. 7. MILLING MACHINES

Arrangement of Millers

We now come to the milling machines, Fig. 7. No other type of machine provoked the discussion in connection with arrangement which was given to the milling machines. Advocates were found for the method which was finally adopted and shown herewith, for the older method of setting them in diagonal rows across the building and for the method of setting them back to back with an operator between two machines. A careful analysis was made of these three systems, and it was determined that the method illustrated was the most economical of floor space and gave the best arrangement of machine tools and the individual bench for the use of the operator. Here as in the case of other of the machine tools, an individual bench was provided for each pair of machines. It will be noted that the same method is used for the small machines as well as for the large.

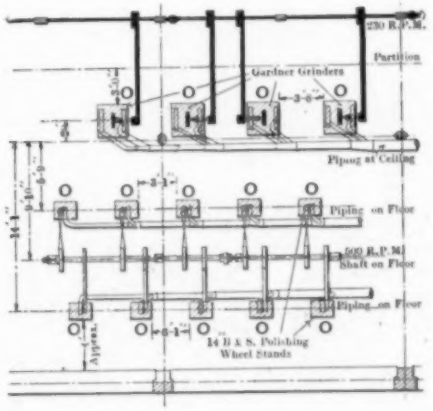


FIG. 8. POLISHING MACHINERY

In passing it might be stated that this arrangement of the milling machine presents a very pleasing effect when worked out for a large department. In the department referred to there are about 180

milling machines of various sizes. Each machine is readily accessible and the general results are good.

Arrangement of Polishing Machinery

Fig. 8 shows the lay-out for the polishing and grinding machinery. The machines are all set in parallel rows lengthwise of the building. The polishers are driven from a shaft located on the floor between the two rows. The disk grinding machines are driven from an overhead shaft. The cut also indicates the piping of the exhauster system.

Other Manufacturing Departments

The arrangement of the machine tools has now been covered for all the general manufacturing departments with the exception of the cam cutting and gear cutting. The gear cutters and cam cutters of the milling-machine type were set according to the milling-machine lay-out. Cam cutters of the lathe type were set according to the lathe lay-out.

Fig. 9 shows one of the general bench departments on one of the manufacturing floors. Nothing but cross benches is used for this class of work. A study of the photographs will show that the light is excellent even at the end of the bench which is near the center of the room.

Arrangement of Screw Machines

Figs. 10 and 11 are shown as illustrating the way in which hand and automatic screw machines were set. While these do not concern the general manufacturing department we have been considering, they are still of interest. The noticeable features of these two lay-outs are that the automatic machines are set at an angle with the lines of the building in order to accommodate as many machines as possible on a given floor space, while the hand machines are set parallel with the lines of the building in diagonal rows. It was not deemed advisable to run the hand machines which have a cone belt at an angle with the main line shafting. The hand machines each have the individual workman's bench. Individual benches have been provided for the automatic screw-machine operators, but as there is only one bench to several machines it was not deemed necessary to select a specific location on the lay-out.

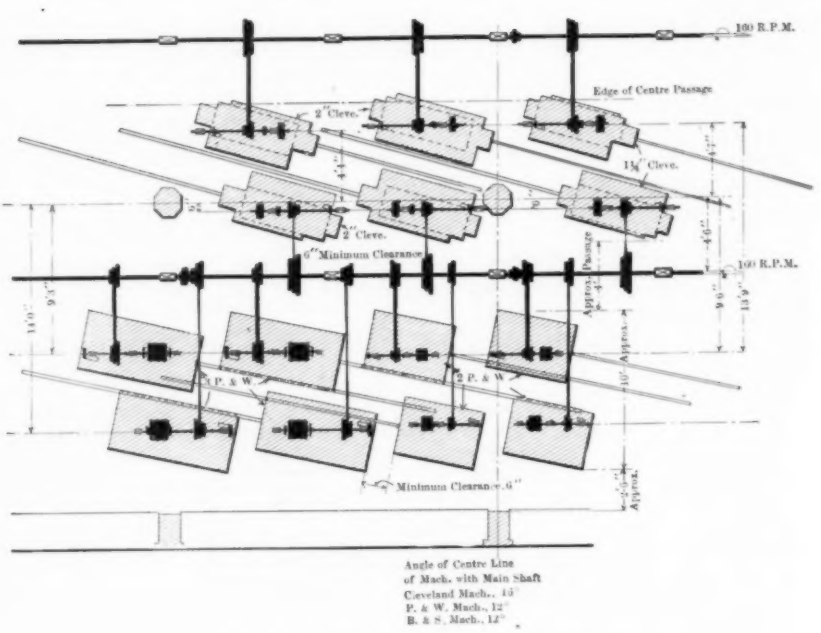


FIG. 10. AUTOMATIC SCREW MACHINES

FIG. 9. A BENCH DEPARTMENT

Experimental and Tool-making Departments

A lay-out for these departments is shown in Fig. 12. This shows both lathe and milling machines. The same arrangements of the machine tools between benches was carried out for drills and planers. In these departments a bench is essential for each workman, and the cross benches between machine tools seem to afford an easy solution of the problem of providing each man with a bench space adjacent to the machine tool which he might be operating. In addition to bench space in connection with the machine tools, a general bench department or bench section was also provided for both the experimental and tool shops.

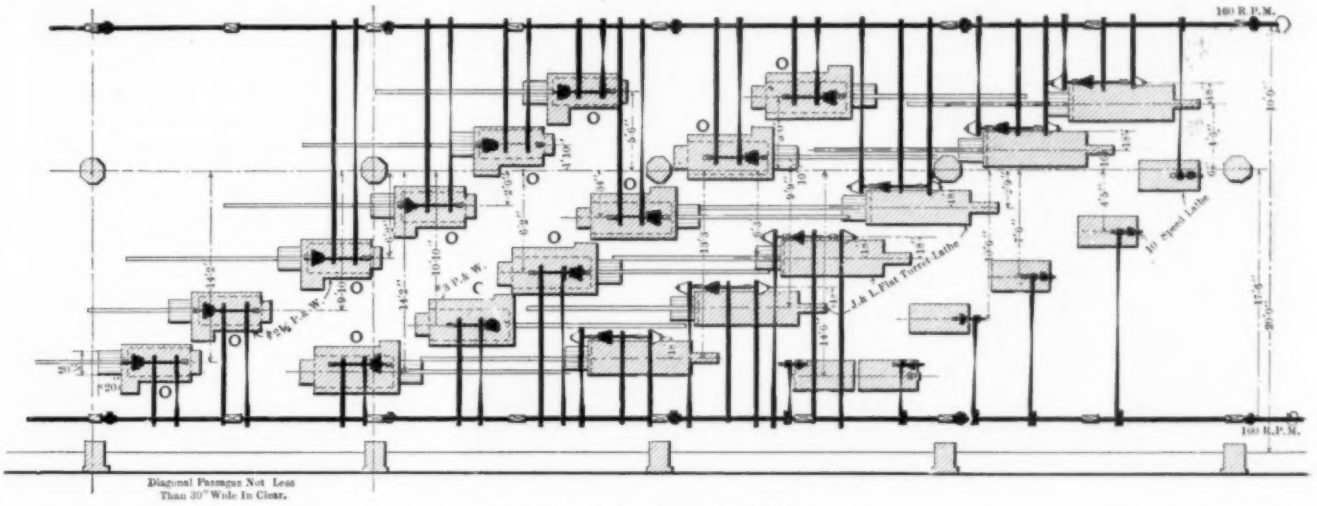


FIG. 11. HAND SCREW MACHINE

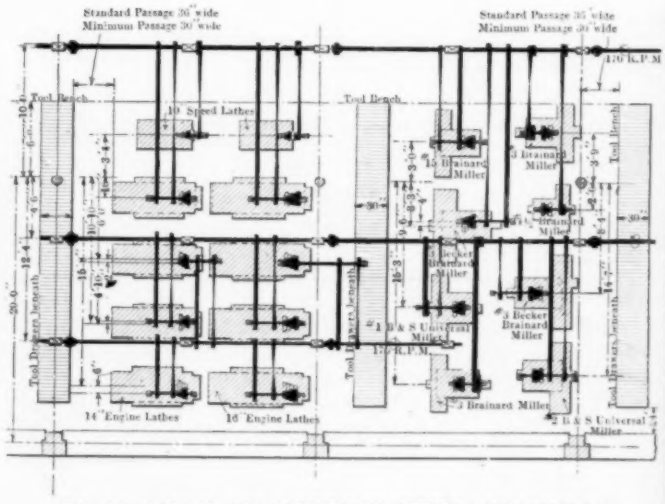


FIG. 12. LATHES AND MILLERS IN SPECIAL DEPARTMENTS

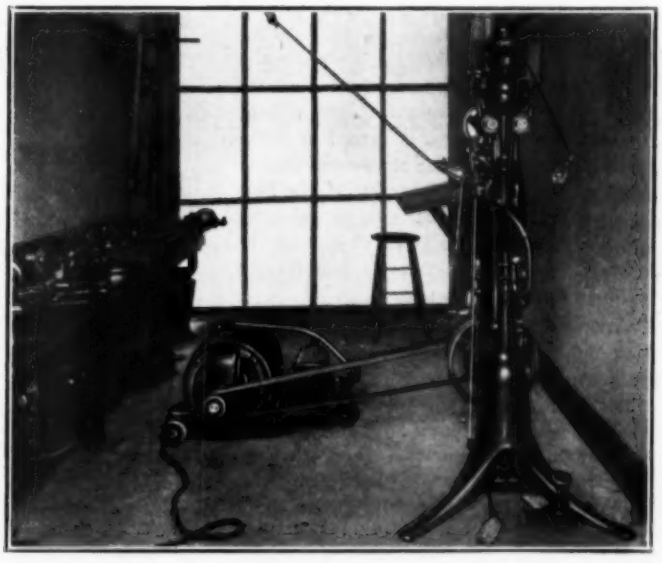


FIG. 13. A SECRET EXPERIMENTAL ROOM

The half-tone Fig. 13 shows the interior of a secret experimental work room. There are about twenty of these rooms and an equal number of similar rooms used for drafting. In general an inventor has two rooms, one for drawing and the other for testing a new machine. The cut, the photograph for which was taken from the open door, shows the work bench and a machine belted to a motor. This motor is direct current, 110 volts and variable speed, having a ratio of 4:1. It is mounted on a truck, together with the fuses and controller. A flexible cable connects with a plug switch, permitting the motor to be placed in the room in any position desired. Three motors of the following sizes are mounted for this purpose: ⅝, 2 and 5 horse-power.

The inventing staff of the company is very highly organized and has at its command the best of the factory help—draftsmen, designers and machinists. Its machine-tool equipment is also of the best. Facilities are at hand for testing all of the machines, and long shoe-shop trials are also carried on for new machines and devices.

Fastening Machines to Concrete Floors

One question which is frequently asked in connection with the setting of machine tools is: How are they fastened to the concrete floors? At first thought this may present some difficulty, but as worked out by the engineers of the United Machinery Company it proved very simple. Machine tools having box frames or a large flat base, as in the case of some planers, milling machines and the like, are placed in the location which they are to occupy upon the floor and are then wedged up a distance of about three-quarters of an inch. A stiff cement mortar is then troweled under the base, so that it will reach in from all edges a distance of three or four inches. The wedges are then slacked back a short distance, so that the machine drops into this soft bed of cement mortar and is perfectly level. After setting about 24 hours the wedges are removed, and if the cement mortar has properly set, the machine is ready to use. In this method there is no drilling of the concrete floor whatever, and if a machine is moved from one location to another, the concrete or cement mortar which was used for setting can be scraped from the floor and presents no permanent disfigurement or injury. In setting planers it is well to have the planer bed upon permanent steel shims, in order that the

vibration of the machine will not tend to powder the cement mortar and thus throw the machine out of level.

For machines having legs, such as lathes and small planers, and for machines which are top heavy, such as upright drills, the feet or base are fastened to the floor by means of expansion sleeves and lag screws, which enter holes drilled in the floor itself. With good workmanship this forms a very secure fastening. The holes which the sleeves enter must be of the right diameter, or else the sleeve will be broken when the screw is forced in if the hole is too small; or the sleeve will not expand and grip in the concrete if the hole is too large. Care must also be taken in drilling these holes to avoid shattering the lower surface of the concrete floor or the ceiling of the floor below.

Another point in connection with setting milling machines is worthy of mention. In no case were holes made in the concrete floors for the elevating screws. Instead, such machines as were not provided with a telescoping screw were fitted with a very long nut at the base of the machine, and the screw was cut off. This shortened the travel of the knee slightly, but not enough to injure the tool for general manufacturing work. Millers purchased since the plant began to operate have been ordered with a telescoping screw.

In these cases, as in many others in connection with concrete construction, attention to detail is imperative in order to obtain good results.

FIG. 14. THE EMERGENCY HOSPITAL

The Emergency Hospital

One other department of the plant, which is not a manufacturing department, will be considered in closing. In the heart of the manufacturing area, located in a room in the center wing, is a room devoted to the emergency hospital. This room is shown in Fig. 14. It is light and sunny, having a southern exposure, and is thoroughly equipped for its purpose, as the half-tone shows. An attendant is always at hand to care for whatever accidents or injuries may occur throughout the entire plant. The room is equipped with a line of hospital furniture, appliances, and instruments, so that accidents can be cared for on the spot. In fact minor amputations are at times performed. A careful record of all cases is kept and an average is from 12 to 14 per day. The total number of employees in the plant is about 3000.

Making Nurls

By E. A. Dixie

For the ordinary run of work it is hardly ever necessary to originate a nurl, as so many varieties of nurls are kept in stock in the large supply houses; but when something special comes along, or a man is in a little one-horse country shop a thousand miles from a supply house, things are very different.

Plain, straight fluted nurls are probably easiest to originate on the milling machine. The blank is, of course, turned, bored and mounted on an arbor in the dividing head. For coarse nurls an ordinary angle mill is all right, providing it runs true; but for fine nurls a single-pointed tool secured to the milling-machine arbor will be found to do better work. The arbor should be stationary and the tool used the same as a planer tool. Straight flute nurls can be originated also in the shaper, using either the dividing head or rigging up so as to use any suitable gear as a dividing wheel. Plain spiral flutes are, of course, easily produced in the milling machine, and with little rigging up in the shaper or planer.

I once had the job to make a fine nurl the same pitch as a file that was brought into the shop. The file was cut 170 to the inch, and I had no dividing arrangement which would give me anywhere near a fine enough spacing on the blank, which was about 1⅛ inches in diameter. I clamped the file, which was fairly flat, to the table of the shaper, and held the nurl holder

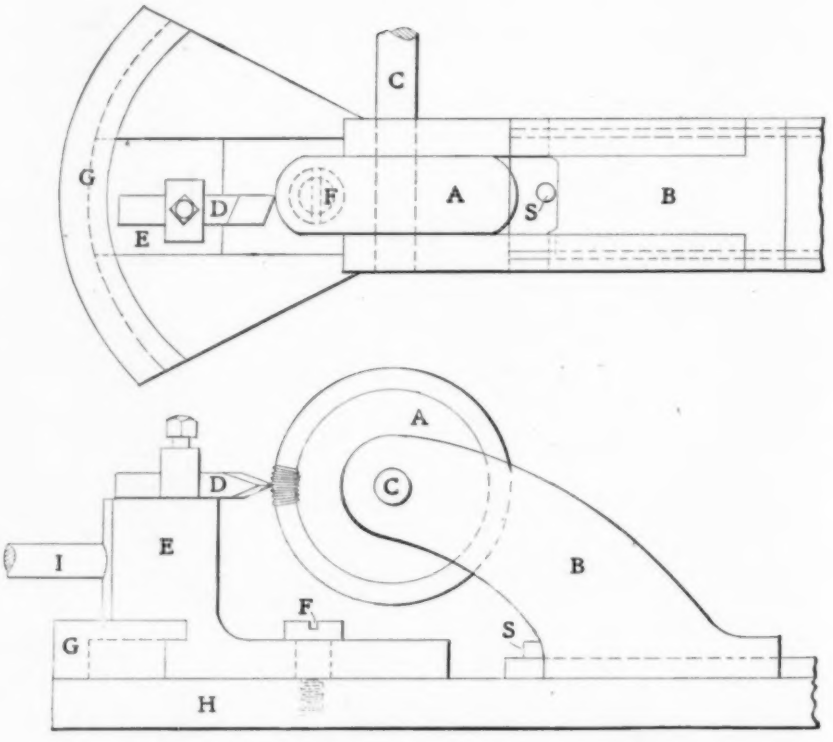


FIG. 1. FIXTURE FOR MAKING CONVEX AND CONCAVE NURLS

with the blank nurl in it in the tool post. The clapper block was fastened down, and the blank rolled backward and forward over the file. The resulting nurl was all right for the job for which it was intended.

In hardening nurls, especially fine-toothed nurls, the blanks should be covered with file-cutters' paste before heating them, as the paste protects the face. The paste used in the Government shops is made of:

Pulverized charred leather...	1 lb.
Fine family flour.....	1½ lb.
Fine table salt.....	2 lb.

The charred leather should be powdered fine enough to pass through a No. 45 sieve. The ingredients are thoroughly mixed dry and then the water is slowly added, to prevent lumps forming, until the paste is about the consistency of thin molasses. The paste is applied with a brush and the article allowed to dry slowly and thoroughly before heating to harden. If in a hurry to harden, or having no file-cutters' paste, rub the nurl with common hard soap so that the teeth are filled, and heat in the usual way. This is not as good as the paste, but is a great deal better than nothing at all.

ished. It is obvious that if the tool slide be advanced so that the point of the tool is beyond the pivot *F*, concave mills can be cut.

Where convex or concave nurls with oblique teeth are required, a former of sheet steel of the desired shape is easily made. The tool slide is arranged so that it can be swung to the correct angle and a roller on the slide engages with the former.

Where a concave-faced nurl with fine teeth is required and where the direction and the shape of the teeth are of no consequence, it can be hobbed in the lathe with a fine-thread hob tap between centers, the blank nurl being mounted in the holder and the holder clamped on its side so that the blank rotates in a horizontal plane at the correct hight.

Fancy pattern master nurls are engraved, and in the making of them great care must be exercised to make them match up correctly. The pieces to be nurled must be accurately sized, so that the pattern will match correctly.

Fig. 2 shows a variety of nurls. The two nurls shown to the left are for watch-case work. The master nurls with which they were made were hand chased. The

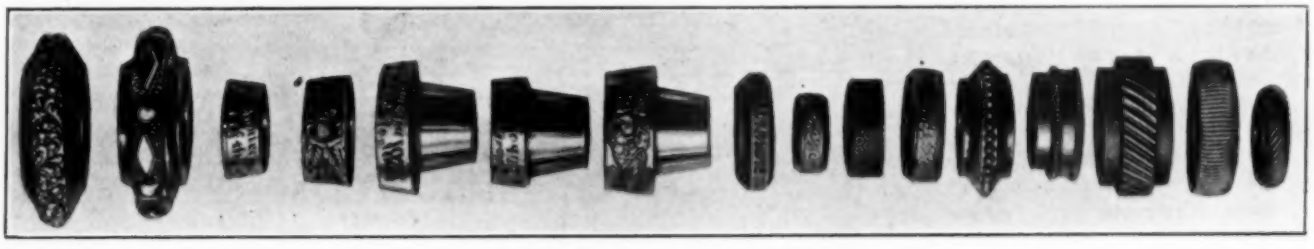


FIG. 2. A VARIETY OF NURLS

Round- and hollow-face nurls are produced in various ways. A very simple device is shown at Fig. 1.

The nurl blank *A* is mounted on the spindle *C*, which is supported by the bracket *B*. The spindle *C* has a suitable indexing device mounted on one end of it. The bracket *B* is mounted on a slide, and can be moved to or from the pivot screw *F*. The slide upon which it works is provided with a stop *S*, which can be set so that *B* can be drawn back and reset in the same position instantly.

The tool-carrying bracket *E* is also provided with a slide, not shown, so that the tool point can be set at any distance from the center of the pivot screw *F*. A gib *G* and the pivot screw *F* hold the tool-carrying bracket *E* to the bed plate *H*. The tool bracket *E* is provided with a lever *I*, so that it can be swung on the pivot screw *F*.

After the tool *D* and the stop *S* are set to correct position, the first cut is taken. Before returning *D* to cutting position for the next tooth, the bracket *B* is drawn back and the blank *A* is indexed. The tool is then swung to starting position, *B* is brought back to the stop *S*, the next tooth is cut, and so on till the nurl is fin

next two are original hand-engraved master nurls, and the next three are nurls made from them. These were used to nurl tapered ferrules. With these nurls, as the pattern does not reach all around the surface, the master and the blank were rocked back and forth the full length of the engraved pattern until the reproduction was finished.

The next is an engraved master nurl. In this there is a series of cross lines with little scrolls at regular intervals. The scrolls not only have to be spaced accurately but must bear a fixed position with relation to the cross lines, which must also be accurately spaced.

Next to the master is the reproduction. The next nurl is a small hexagonal pattern with a six-pointed star in the center of each hexagon. This is also reproduced from an engraved master.

The next is reproduced from an engraved master. The rest of the nurls, while a little out of the ordinary, were produced from master nurls that were machine made.

Gum-shellac is soluble in a solution of borax in water. A lacker for metal was at one time made in this manner.

Standardization of Drawing-room Methods

By J. Stoneham

Standardization of drawing-room systems and methods I consider of great importance. Very many drawings have repetition work which, if made standard, could be signified by a mere outline and definite symbol by which to refer one to a standard sheet upon which the article would be fully detailed. Every drawing room should have a series of volumes of these standard sheets which could consist of blue prints in strong covers and of a fixed size and known series symbol.

In an electrical firm, for example, everything pertaining to switchboards would be detailed on sheets *S*, and such-and-such a switch would be fully described as *S2*—32, part 32 on sheet number 2 in series *S*. So induction-motor parts, turbine details, etc., on sheets *I* and *T* could be fully referred to upon assembly drawings by a standard recognizable outline indicated in plain figures in its proper code symbol as above. This system has the advantage that if a dishonest employee wishes to take away drawings of assembled machines for outside reference he also has to steal whole volumes of standard sheets without which the principal drawing is practically useless.

A volume of blue prints may seem rather rough and ready to anyone unused to such a system, but the writer has tried the method and finds it excellent. Besides, whenever a slight modification is made in any article one merely has to print as many blue prints as there are volumes of that particular series in circulation and replace the now obsolete sheet with the latest modification. Under such a system the actual drawing of the assembled machine will not occupy one-quarter of the time which would otherwise be spent upon it had the draftsman to elaborate every part, and will be perfectly clear to the firm's employees who will recognize every part by its code of letters and numbers and not have to refer to the standard sheets except for the rarer apparatus. Perhaps the American Machinist will welcome contributions on this interesting question of standardization.

A Problem in Crane Track Design

By Con Wise

I recently had occasion to design a traveling crane, and found a computation that was beyond me. Fig. 1 shows a part of the rail or track on which the bridge was to run, with the crane wheels indicated in the center of the span. The span between centers of supports was 24 feet, and the distance between crane wheels was 8 feet. I could find formulas for this easily enough if I cut up the track into 24-foot lengths, and rested the ends on the posts, but that is just what I did not want to do. I wanted to make my beams continuous over the posts, and to take advantage of any gain that there might be in that construction.

I know a young fellow who is attending a technical school, so I told him my troubles and he said he would help me. The next day he told me that there was nothing in any of the text-books in their library that would help me, but that he thought he had a solution. I will set down what he gave me for your readers' criticism. It involves more mathematics than some of us fellows like to admit is desirable; but if those of your readers who can will pass judgment on it, then the rest of us can use the results. They are simple.

In the first place the conditions of the problem as he took it are as shown in Fig. 1, where $c\,b$ represents a 24-foot section of the beam from the center of one post to the center of the next, and $P\ P$ represent the loads on the wheels at points equidistant on each side of the center. Neglecting the weight of the beam, the posts each have to hold up a weight equal to P, or as he has put it, P_1 at each end. The beam is fastened to the posts in such a way that it must remain horizontal over them. This condition, he says, may be represented by a pull on the top of the beam (horizontally) and a push on the bottom, as at M_c and M_b. The amount of these forces is unknown at present. He calls this pull a push multiplied by the depth of the beam M_c or M_b, and then goes to work to find out what it is.

Taking a section at any distance from the center x, between d and the right-hand P, he writes the following equation for the bending moment at and in that section. (He tells me that any student of mechanics will recognize its form.)

$$E\,I\,\frac{d^2\,y}{d\,x^2} = P(a - x) \quad M_b - P(\tfrac{1}{2} \quad x). \quad (1)$$

If x is greater than a this will be:

$$E\,I\,\frac{d^2\,y}{d\,x^2} = M_b - P\left(\frac{l}{2} - x\right). \quad (2)$$

If (1) and (2) are integrated once, they will represent the slope of the curve which the beam takes, so (1) becomes:

$$E\,I\,\frac{d\,y}{d\,x} = P\,a\,x - \frac{P\,x^2}{2} + M_b\,x - \frac{P\,l\,x}{2} + \frac{P\,x^2}{2} + (constant).$$

Since the slope is zero at the center, $x = 0$; then $c = 0$, and it reduces to:

$$E\,I\,\frac{d\,y}{d\,x} = P\,a\,x + M_b\,x - \frac{P\,l\,x}{2}; \quad (3)$$

(2) becomes:

$$E\,I\,\frac{d\,y}{d\,x} = M_b\,x - \frac{P\,l\,x}{2} + \frac{P\,x^2}{2} + c.$$

When the slope is equal to 0, and x is greater than a, $x = \frac{l}{2}$.

$$\therefore\ 0 = \frac{M_b\,l}{2} - \frac{P\,l^2}{4} + \frac{P\,l^2}{8} + c.$$

and

$$c = \frac{P\,l^2}{8} - \frac{M_b\,l}{2};$$

(2) becomes:

$$E\,I\,\frac{d\,y}{d\,x} = M_b\,x - \frac{P\,l\,x}{2} + \frac{P\,x^2}{2} + \frac{P\,l^2}{8} - \frac{M_b\,l}{2}. \quad (4)$$

(3) and (4) are now the equations for

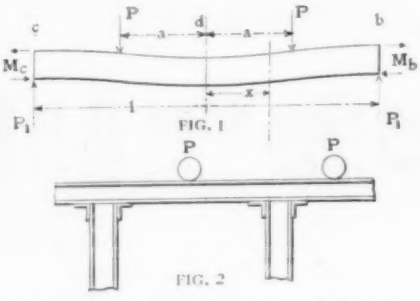


FIG. 1

FIG. 2

A PROBLEM IN CRANE TRACK DESIGN

the slopes of the beam between d and P and between P and b. Under P the slope of each is the same and $x = d$, so equating the right-hand sides of (3) and (4) and making $x = a$, we have:

$$P\,a^2 + M_b\,a - \frac{P\,l\,a}{2} = M_b\,a - \frac{P\,l\,a}{2} + \frac{P\,a^2}{2} + \frac{P\,l^2}{8} - \frac{M_b\,l}{2}, \quad (5)$$

which, solved for $M\,b$, gives:

$$M_b = \frac{P\,l}{4} - \frac{P\,a^2}{l}. \quad (6)$$

This is the bending moment over the post. We do not care how M_c is made up. It is the product of a force applied at the top or bottom of the beam by the depth of the beam, and we can use it in the formula which is familiar to all of us:

$$M = p\,\frac{I}{c},$$

where M is the bending moment applied at a given section of a beam, p is the allowable fiber stress, $\frac{I}{c}$ is the section modulus from any of the hand-books.

In this case l is 24×12 288 inches, P is (about) 10,000 pounds, and a is 48 inches; p we take as 12,000 pounds.

$$\therefore\ \frac{I}{c} = \frac{\frac{10{,}000 \times 24 \times 12}{4} - \frac{10{,}000 \times 48 \times 48}{24 \times 12}}{12{,}000} = 53\tfrac{1}{3},$$

which calls for a 15-inch 42-pound beam if an I-beam is to be used.

The next question is, How do we know whether the greatest bending moment is over the post or not?

Referring again to Fig. 1, if we write an expression for the bending moment at the center it is:

$$M_c = P\,a + M_c - P\,\frac{l}{2}, \quad (7)$$

and under the load:

$$M_p = M_c - P\left(\frac{l}{2} - a\right), \quad (8)$$

which, expanded, is identical with (7).

Now the only case when M_c or M could be greater than M_c would be when a was greater than $\frac{l}{2}$, which would be when the distance between the crane wheels was greater than the distance between the supports. There is still another possibility, and that is that if the distance between the crane wheels is too great, the beam would be stressed more by one wheel at the center of the span than by two wheels equally spaced from the center. See Fig. 2.

In this case the bending moment (maximum) is $\frac{P\,l}{8}$. If this is greater than M_c, which was found to be equal to $\frac{P\,l}{4} - \frac{P\,a^2}{l}$, then the beam should be figured as fixed at the ends and loaded at the middle. If we put $\frac{P\,l}{8} = \frac{P\,l}{4} - \frac{P\,a^2}{l}$ and solve for a, it will give the distance from the center of the beam beyond which this second method should be followed. Doing this we find:

$$a = \frac{l}{\sqrt{8}} = \frac{l}{2\,828} = 0.354\,l.$$

That is, if the spacing of the wheels is a trifle over 0.7 of the span, the figuring should be done on the basis of one wheel load at the center of the span.

This solution helped me out of a hole, not so much because of its actual results as because it made me feel as if I had a good basis to figure on. I hope it may help someone else.

Some of the steel foundries have become constant consumers of old brass crucibles. They are ground up and used in molding sand.—*The Brass World.*

A well known firm is considering erecting a wood-working shop with steel framing but floors built up of 2x6-inch planks on edge, and spiked together. On top of this will go the regular 1¼ maple flooring, making 7¼ inches of wood in the flooring.

5 x 48-inch Automatic Sizing Grinder

A Machine Having an Electrically Controlled Feed and Sizing Device for Enabling Duplicate Work to be Automatically Ground

SPECIAL CORRESPONDENCE

The accompanying half-tones and line engravings illustrate a grinding machine which is designed for handling either cylindrical or taper work up to 5 inches diameter by 48 inches long, and provided with a sizing device and electrically controlled feed by means of which duplicate parts may be automatically finished to uniform size regardless of the wear of the wheel during the progress of the work. When the mechanism is once set for the first piece ground, the operator has simply to remove the piece when completed, place another piece between the centers and start the feeding mechanism, which continues to advance the wheel to the work until the latter is ground down to the required size, when the feed is automatically thrown out of action. The ingenious mechanism for accomplishing this important operation of bringing the work accurately to size without the necessity upon the part of the operator of calipering the diameter and feeding the wheel slide to compensate for any wear of the wheel prior to the final finishing passes provides for the taking of coarse feeds until the work is nearly to size, when a very fine feed is automatically thrown in for the finishing operation.

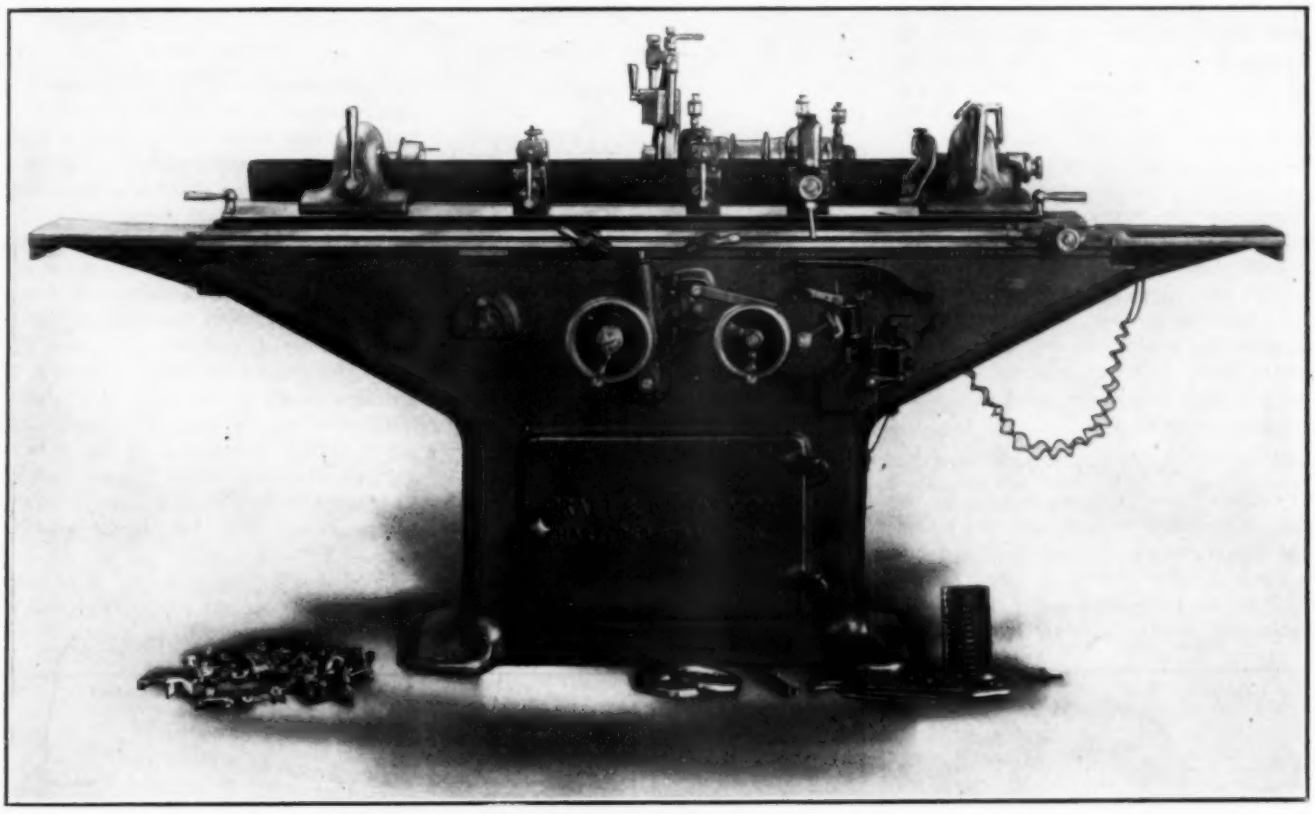


FIG. 1. 5x48-INCH AUTOMATIC SIZING GRINDER

The Bed and Table

A good idea of the appearance of this grinder, which is designed and built by the Pratt & Whitney Company, Hartford, Conn., is given by the half-tones Figs. 1 and 2, showing front, rear and end views of the machine. As will be seen, it is of deep, heavy construction to absorb vibration, the bed which is cast in one piece and rests on three points being well ribbed and stiffened by cross girts in all directions.

The work table is provided with a V and a flat way on the bed, and has a T cross-section with a deep rib to which the rack is fastened. This stiffens the table and prevents its springing when it is run well off from the bed. The slide which is mounted on the top of the table is rigidly secured by a clamp at each end and swivels at the center. At the right-hand end is provided an adjusting device for taper grinding which is so arranged that 125 graduations give ⅛ inch per foot taper. This device is easily adjusted by the operator, as the graduations showing the inches or fraction of an inch taper per foot are arranged on the same principle as those on the micrometer caliper.

The T-slot extends the whole length of the swivel table for fastening the head and foot blocks and other appliances, and the water guard is fastened on the inner edge so as to thoroughly protect the surface of the slide from water and emery. The head and foot stocks are of "goose-neck" pattern, allowing the guard to pass outside the work placed between them; they are held in position with eccentric clamps and are quickly adjusted along the table. The driving pulley on the headstock has dust-proof bearings; the construction is clearly shown in the sectional drawing Fig. 3.

The footstock spindle shown in section in Fig. 4 is manipulated with a lever at the top. When spring tension is not desired on the work, a clamp is provided to clamp the spindle in any position desired. The spring pressure is also regulated by turning the nurled knob at the rear end of the footstock.

The Wheel Slide

The emery-wheel slide is made very heavy in order to absorb vibration due to wheel and belt; it is carefully fitted to the bed, and a taper gib is provided for its adjustment. The feed is by means of a screw of large diameter to avoid any torsional effect likely to cause the slide to jump ahead. The latter member is so fitted that when fed forward a fraction of a thousandth it will immediately respond. In order still further to prevent any tendency of the emery wheel toward "jumping in" to the work, the slide is connected through a cable with a weight which always keeps the nut in proper contact with the feed screw on the forward side of the thread.

The sectional drawing Fig. 5 shows the construction of the spindle and its bearings. The spindle is of tool steel, hardened, ground and lapped. The boxes are of bronze and are adjustable positively in both directions from one end without removing the wheel. End thrust is taken by an independent adjustment which is also easy to get at. Lubrication is through the medium of sight-feed oil cups. The brackets in which the boxes are held can be swiveled in all directions. When the spindle and its boxes are assembled, the screws are loosened on the brackets, the spindle placed in the boxes, the boxes adjusted, and afterward the brackets tightened with the screws. This insures alinement of the boxes with the spindle. The emery wheel is readily removed, and it is not necessary to take the spindle out when changing wheels.

The Table Feed

Automatic reciprocating motion to the table is provided through rack and pinion, the reverse being through hardened and ground clutches shifted by means of the well known knife-edge spring points. The table will reverse within one-thousandth of an inch, thereby making it possible to grind close to the shoulder. The trips are adjustable along the table, and when it is desired to true up the emery wheel with a diamond, it is only necessary to lift the trip over the swinging arm end, and the truing-up operation can then be accomplished by movement of the table, without disturbing the trip adjustment for the work being done.

The automatic motion is engaged by pulling out the knob at the center of the large hand wheel shown in Fig. 1 at the front of the machine, and the hand wheel is also disengaged from the shaft so that

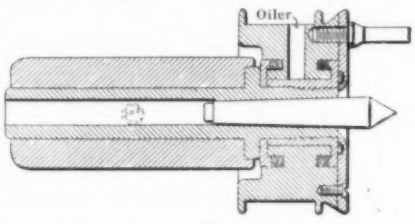


FIG. 3. SECTION OF WORK-DRIVING PULLEY

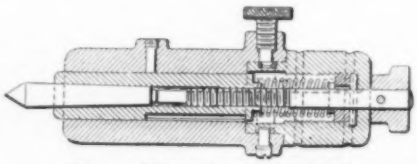


FIG. 4. SECTION OF FOOTSTOCK

it will not run back and forth. When the knob is pushed in, it disengages the automatic feed and re-engages the hand wheel with the shaft. The speed of the table is easily controlled by the crank handle, shown to the left of the hand wheel, and the rate of speed can be changed while the machine is running.

The Wheel Slide Feed

This feed mechanism embodies new and highly ingenious features, it being possible as stated in the opening paragraph to start with a coarse feed and, when the work is nearly to size, have the fine feed automatically thrown in for the finishing operation, thus obviously resulting in a considerable saving of time. The feeds can be controlled mechanically (and in this case the same effect is obtained as with any automatic grinder feed) or electrically, where the feed is controlled directly from the work being finished in the machine.

The automatic cross feed is worked from the rocker *M*, Fig. 6, which has a toothed segment revolving a pinion on which lever *L* is fastened. Lever *L* works connecting-rod *N* each time the table reverses, and imparts an oscillating motion to rocker *R*, to which pawl *A* is attached. Screw *J*, against which rocker *R* is shown resting, may be adjusted to determine the number of teeth taken by the pawl *A*, and consequently control the amount of feed.

Electrically Controlled Feed and Sizing Device

The mechanism of the sizing device is clearly shown in the line drawing Fig. 7. In Fig. 1 this device will be seen in position as the work table, and Fig. 8 gives a larger view showing the box opened. Fig. 9 is another view of the sizing device. Its construction will be understood from Fig. 7. In this drawing, *a* represents the emery wheel, *b* is the piece of work being ground, *c* is a smooth diamond point fastened in lever *d*, and resting against the work. At *e* and *f* are rocking levers with platinum points on the ends; *g* is also a platinum point. In lever *d* is an adjusting screw *h*, and in the base of the slide is another adjusting screw *i*, which works against the rocking lever *f*. At *j* is an adjusting screw with micrometer graduations.

Lever *d* is fulcrumed at the point indicated, and its weight when the device is set, causes point *c* to be in constant con-

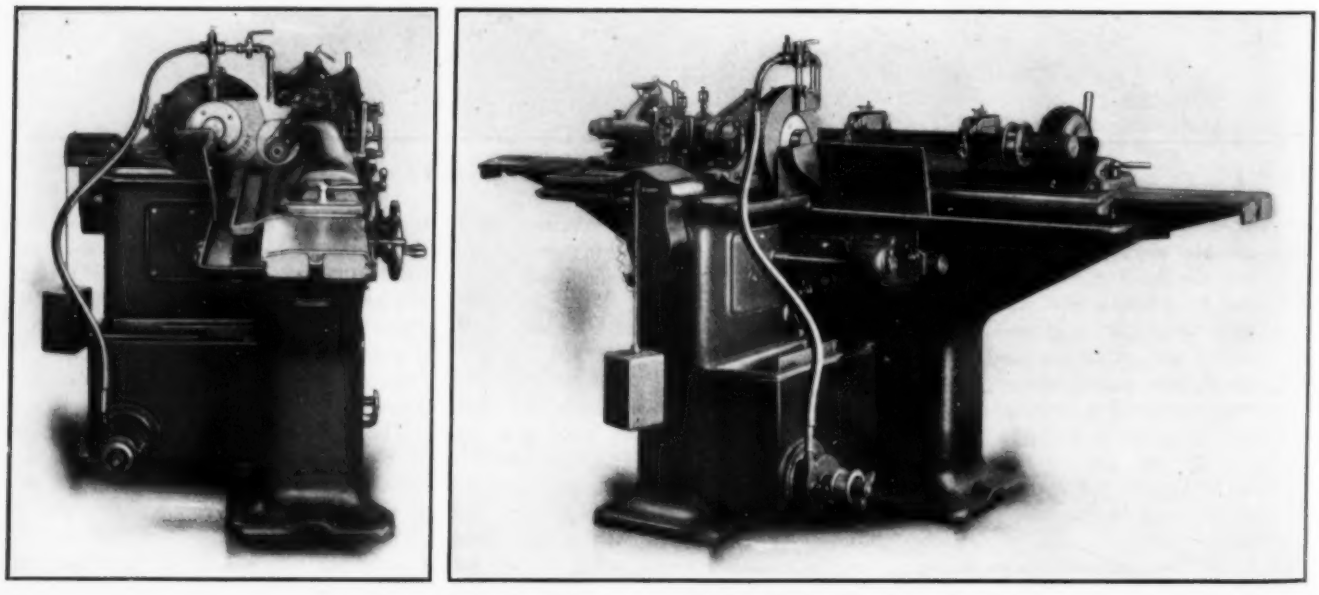


FIG. 2. END AND REAR VIEWS OF AUTOMATIC SIZING GRINDER

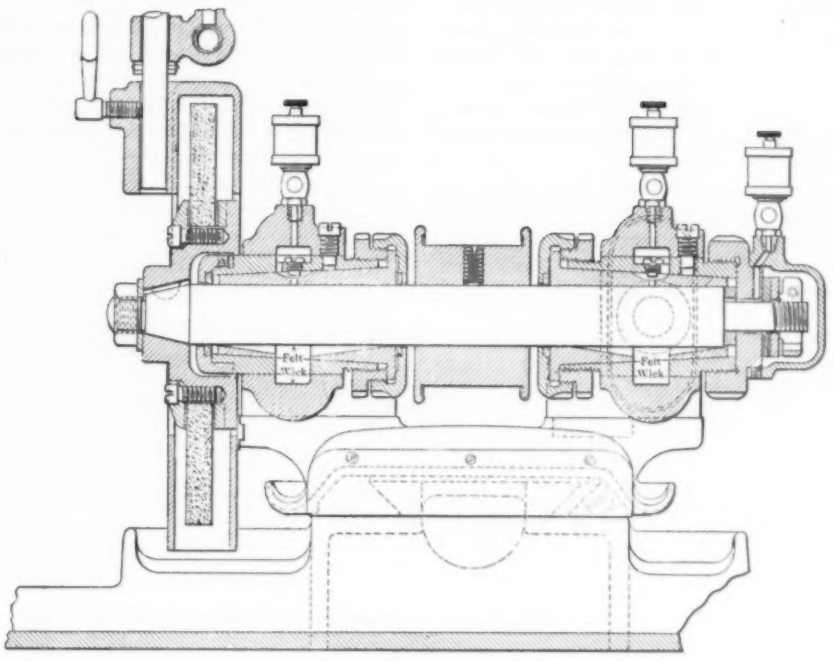


FIG. 5. EMERY-WHEEL SPINDLE AND BEARINGS

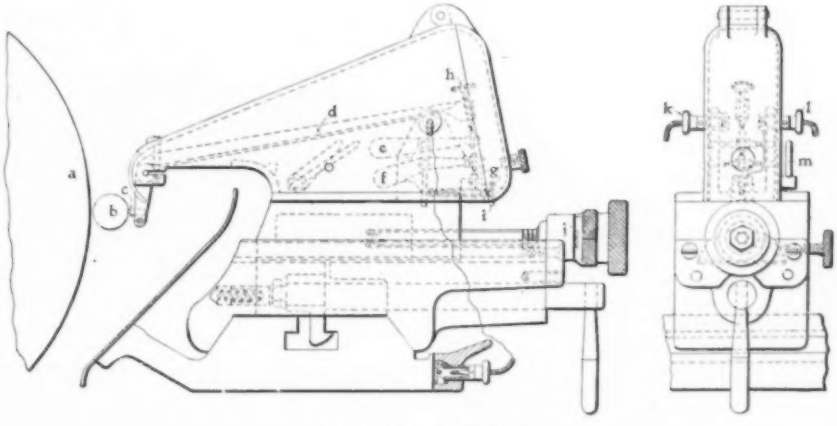


FIG. 7. SIZING DEVICE

tact with the work *b*. After the first piece has been ground to the desired size, the operator turns screw *j* until point *c* comes in contact with the work *b*. Screw *j* is then slowly unscrewed until screw *h* in lever *d* makes a contact on the point of lever *e*, lever *e* just makes a contact with the point in lever *f* and the point in lever *f* makes a contact with point *g*. Of course these adjustments can be made by the combined settings of screws *h*, *i* and *j*.

After the first piece has been removed and a new piece to be ground to the same dimensions is inserted in the machine, point *c* in lever *d* will be brought in contact with the work, and, due to the larger diameter, will cause the lever to stand away from lever *e*. With work in progress and the wheel constantly reducing the diameter, screw *h* in lever *d* slowly drops until it forces the point of lever *e* into contact with the point of lever *f*. At this instant an electrical connection is made which changes the coarse feed into a fine feed, the machine then continuing to reduce the work at a slow rate of feed until point *f* is forced against *g*. The instant this contact is made the feed is entirely thrown out, the work now being exactly the size of the piece to which the mechanism was set.

Operation of the Device

In the drawing of the feed mechanism, Fig. 6, there is shown a rocking lever *H* with an adjustable screw point *I*; this lever is held in position by hook *F*, which is actuated by magnet *G*. When lever *e* on the sizing device, Fig. 7, makes a contact with lever *f*, the magnet *G* on the feeding device becomes active and draws hook *F* out of engagement with lever *H*. When rocker *R* is operated by the next reverse of the machine, lever *H* with its point *I* drops under this rocker and the next time the machine reverses, it feeds only one or two teeth, according to the

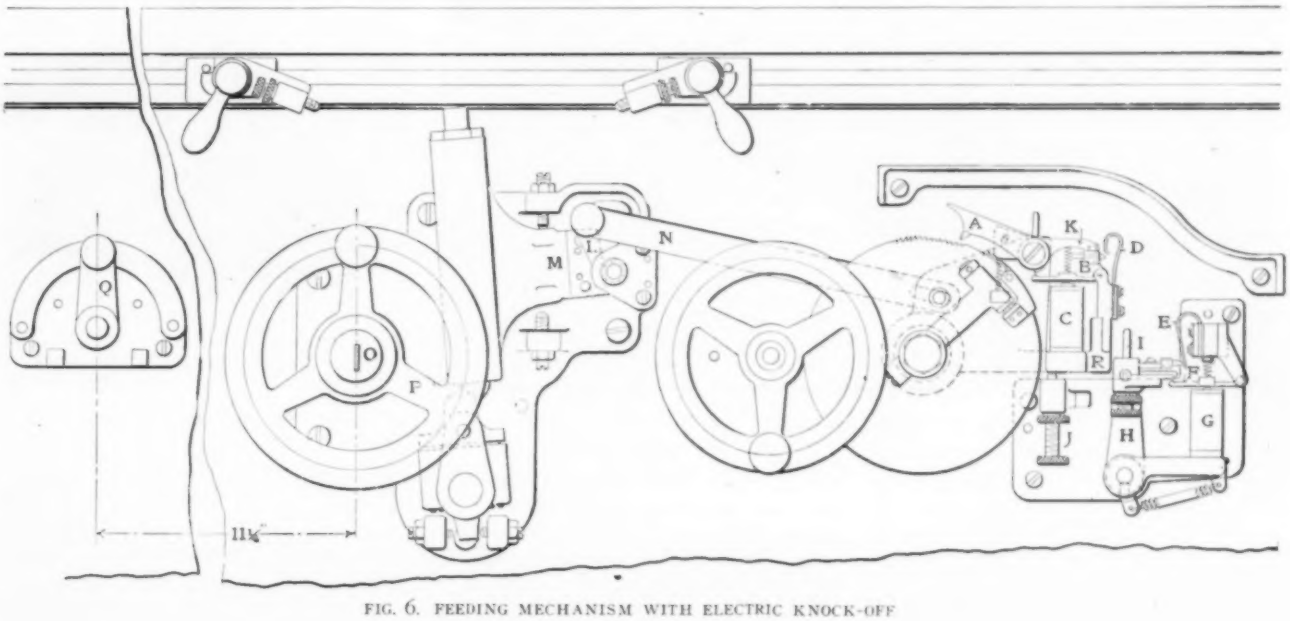


FIG. 6. FEEDING MECHANISM WITH ELECTRIC KNOCK-OFF

adjustment of point *I*. The screw *J* limits the coarse feed, and when it is unscrewed to its full limit, rocker *R* makes its full stroke, carrying pawl *A*, which in turn carries the ratchet wheel with it. When lever *H* is released, the point *I* drops under rocker *R* and limits its motion; this motion can be adjusted to equal one tooth of the ratchet wheel, which represents one-sixteenth of a thousandth of an inch movement of the wheel slide.

The machine now proceeds to feed one or two teeth at a time until the point of lever *f*, Fig. 7, makes a contact with point *g*, when hook *B*, Fig. 6, is drawn out of position by magnet *C*, causing pawl *A* to be thrown out of engagement with the ratchet wheel and the feed to cease operating. It is thus seen that wear of the emery wheel has no effect on the size of the work, the diameter being controlled by the work itself.

Sometimes it happens that the operator wishes to true off the wheel in the middle of an operation, because of its having become glazed; with this machine the wheel can be re-trued or sharpened without having any effect whatever on the accuracy of the work diameter. In the Pratt & Whitney works hundreds of pieces, for instance plug gages, have been ground in one lot on the machine without re-adjustment of the sizing device.

It will be noticed that in the drawing of the feeding device are shown springs *D* and *E*; these springs are of german silver and make the circuit; but the instant hooks *F* and *B* are withdrawn, the circuits are disconnected, thus avoiding sparking at points *g* and the points on levers *e* and *f*, Fig. 7.

Wires are connected from the sizing device to stations along the front edge of the long slide of the machine. Plugs *k* and *l* differ in size so that no mistake can be made in cross wiring, as they will fit only in the correct holes. The electrical apparatus is insulated where required and no short-circuiting is liable to occur. A set of small, dry batteries is regularly furnished with the machine, but the wiring can be arranged (if specified) so that it can be attached by a plug to a lamp socket on a direct-current circuit.

It will be noticed that by adjusting screw *i* on the sizing device, different distances between point *g* and the point of levers *f* can be obtained. The greater the distance, the more stock there will be for the finishing operation to remove. This adjustment is left to the judgment of the operator, who determines how much stock is necessary for finishing. Of course the fewer number of strokes the machine is required to take on the finishing operation, the more rapidly it can produce the work.

On the right-hand side of the sizing device is a trip handle *m* connected by a small shaft with a short lever that rests underneath the long lever *d*. When the short lever is tripped forward it throws lever *d* up, bringing the point *c* out of contact with the work; thus it acts as a protecting device. When the work is in position the first cut should pass by the part on which point *c* rests before handle *m* is tripped again, to allow the point to come in contact again with the work.

It should be stated that the main lever

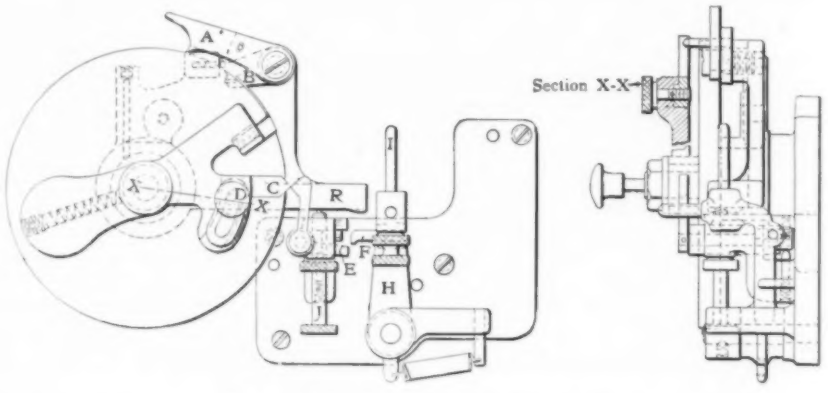


FIG. 10. MECHANICAL FEED VARIATOR

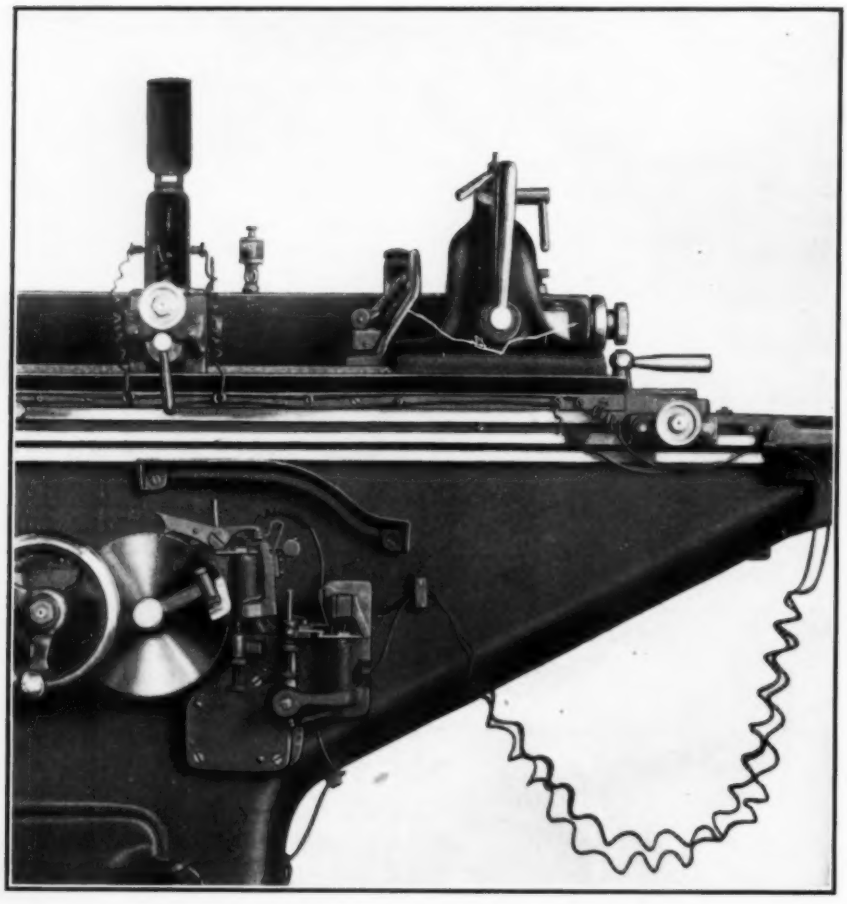


FIG. 8. SIZING DEVICE AND ELECTRIC FEED DEVICE

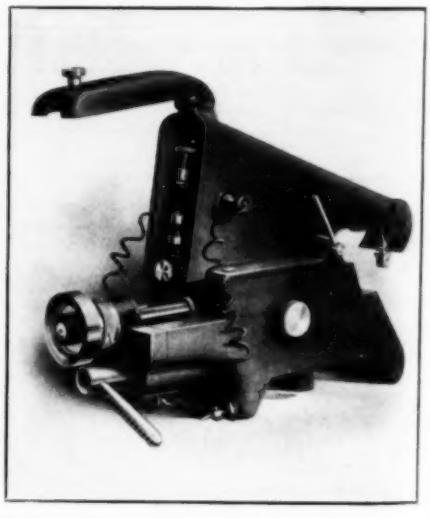


FIG. 9. SIZING DEVICE

d is pivoted on hardened and ground points, over which are mounted sleeves to protect these points from emery and grit, the sleeves being filled with vaseline. The sizing device is easily removed from position when not wanted, by simply turning the handle at the front and pressing it inward. The device can be slipped in and out between the head and foot stock without disturbing the position of either.

Mechanical Coarse and Fine Feed Knock-off

For use in places where the work to be ground may be in nearly all cases of different diameter, and where the electrically controlled feed and the sizing device are therefore not required, the mechanical device shown in Fig. 10 is provided, giving the operator at the start the advantage of a coarse feed, which is automatically thrown over to a fine feed for the finishing cuts.

According to general practice in grinding, the piece is first measured and a truing cut taken, re-measured and the required amount of stock to be removed ascertained. Assuming five-thousandths of an inch is to be removed, as each tooth in the ratchet wheel represents a feed of one-

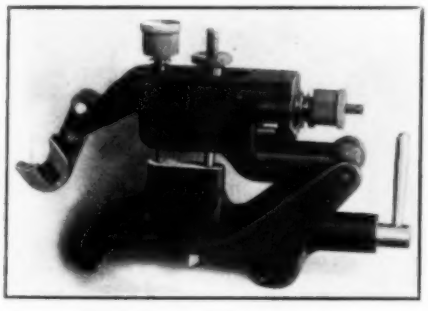


FIG. 11. SELF-FEEDING BACK REST

sixteenth of a thousandth, or a reduction of one-eighth of a thousandth in diameter, eight teeth would reduce the diameter one-thousandth inch and forty teeth will be the total feed required for the five-thousandths of stock to be removed. In setting the trip-mechanism screw, *J*, Fig. 10, is adjusted for the required number of teeth to be taken for each coarse-feed cut, and adjusting screw *I* is set for the fine feed. Shield *B* is then moved back from pawl *A* the number of teeth reserved for finishing cuts, and trip *C* moved upward by screw *D* until lever *E* releases latch *F*, permitting lever *H* to swing over so that adjusting screw *I* will drop under rocker *R* at the next reversal of the machine. The disengaging point on shield *B* is now moved the required number of teeth from pawl *A* (forty in this case, as determined above), lever *H* reset and the grinding operation proceeded with. The machine automatically throws in the fine feed, and disengages pawl *A* when the operation is completed. In reducing another piece to the same diameter, should it be oversize when pawl *A* is disengaged, owing to the wearing away of the wheel, the disengaging point on shield *B* is moved one tooth to the right for each eighth of a thousandth reduction in diameter desired.

The Back Rests

The machine is regularly equipped with two back rests; these are of new design, are adjustable in all directions and rigidly support the work at all times. The construction is shown clearly in Figs. 11 and 12. As will be seen from these two engravings, stops for the forward and upward movements of the rest are provided; after these are set, the vertical feed screw at the front and the horizontal feed screw at the rear are automatically turned by the springs shown to keep the rest positively in contact with the work until the latter is ground to the required diameter. Thus, while the feeding against the material is accomplished by the action of the springs on the screw, the screws themselves hold the rest unyieldingly to the work to insure accurate results, no matter what the reduction in diameter may be. A complete set of bronze shoes suitable for various sizes of work is provided for the rests. Like the automatic sizing device, these rests are readily removed or put in place by turning the handle at the front and pushing it back sufficiently to free the back clamp from the front side of the T-slot.

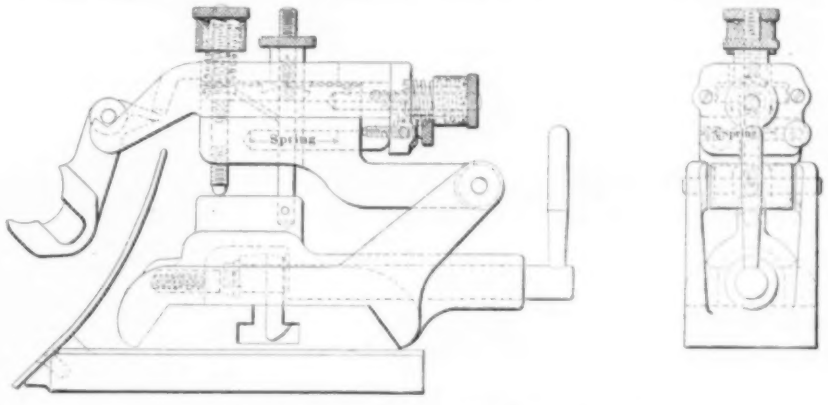


FIG. 12. SHOWING BACK-REST CONSTRUCTION

Wheel- and Center-truing Devices

The wheel-truing device for this machine is illustrated in Fig. 13. It is readily applied and can be put in any position along the table without interfering with the head and foot stocks or back rests. The wheel can be trued up without the work being removed. The center-truing device, Fig. 14, is also constructed at the correct angle and the centers can readily be slipped in and trued up.

The pump for supplying water to the work is driven by a single pulley, no idlers being necessary. This pump, as shown in the rear view, is attached to a large tank in which provision is made for carefully straining the water before it reaches the final compartment, from which it is again distributed by the pump. The countershaft for the grinder is fitted with self-oiling bearings, and the drum is made from wrought-iron pipe finished by turning and grinding.

FIG. 13. WHEEL-TRUING DEVICE

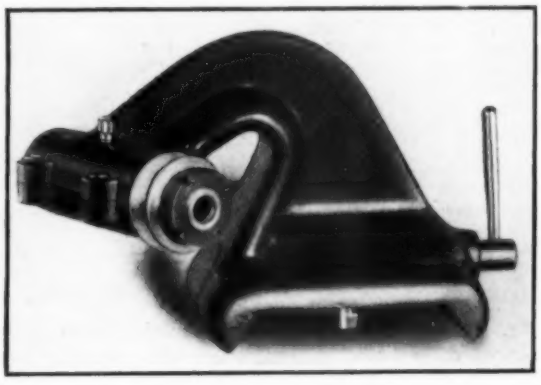


FIG. 14. CENTER-TRUING DEVICE

The Aluminum Industry

All the works engaged in the industry are now producing to the extreme limit of their capacity, while enlargements and extensions are being planned by most of the controlling companies. Aluminum in sympathy with copper, tin, zinc, and lead has shared in the greatly increased demand, and the enormous rise in the price of copper and tin has no doubt served to widen the field of application of the rival metal. The growth of the motor-car industry, in which aluminum is now being extensively employed, has also helped to increase the consumption of the white metal.

The present annual output of the metal is between 15,000 and 20,000 tons, but as all the manufacturing firms decline to publish any figures of their production, no very exact estimate of the aggregate production is possible. All that can be stated with certainty is that the demand in the United States, England and France exceeds the supply. As regards utilization, the limitations of aluminum are now recognized and understood, and the metal is being employed to an increasing extent in the arts and industries, for work which does not demand great mechanical strength in the metal employed. In this country 56 installations of the metal for electric-power transmission purposes can be found, some of these being in connection with schemes of considerable magnitude and importance. This application of the metal has not been followed up in Europe, where doubts exist in the minds of engineers as to its suitability for outside work involving long-continued exposure to humid atmosphere.

At the present moment no less than seven distinct tunnels, formed of 17 separate tubes, are being constructed for the purpose of connecting Manhattan Island, on which New York City stands, with the surrounding boroughs and cities.

The Shaving Machine and Its Work

It is safe to say that comparatively few mechanics, whether they are working in or managing the shop, are fully acquainted with the shaving machine and its work. The name naturally suggests a safety razor of one brand or another, but this has quite another purpose and should be fully as great a time and money saver as the more popular device.

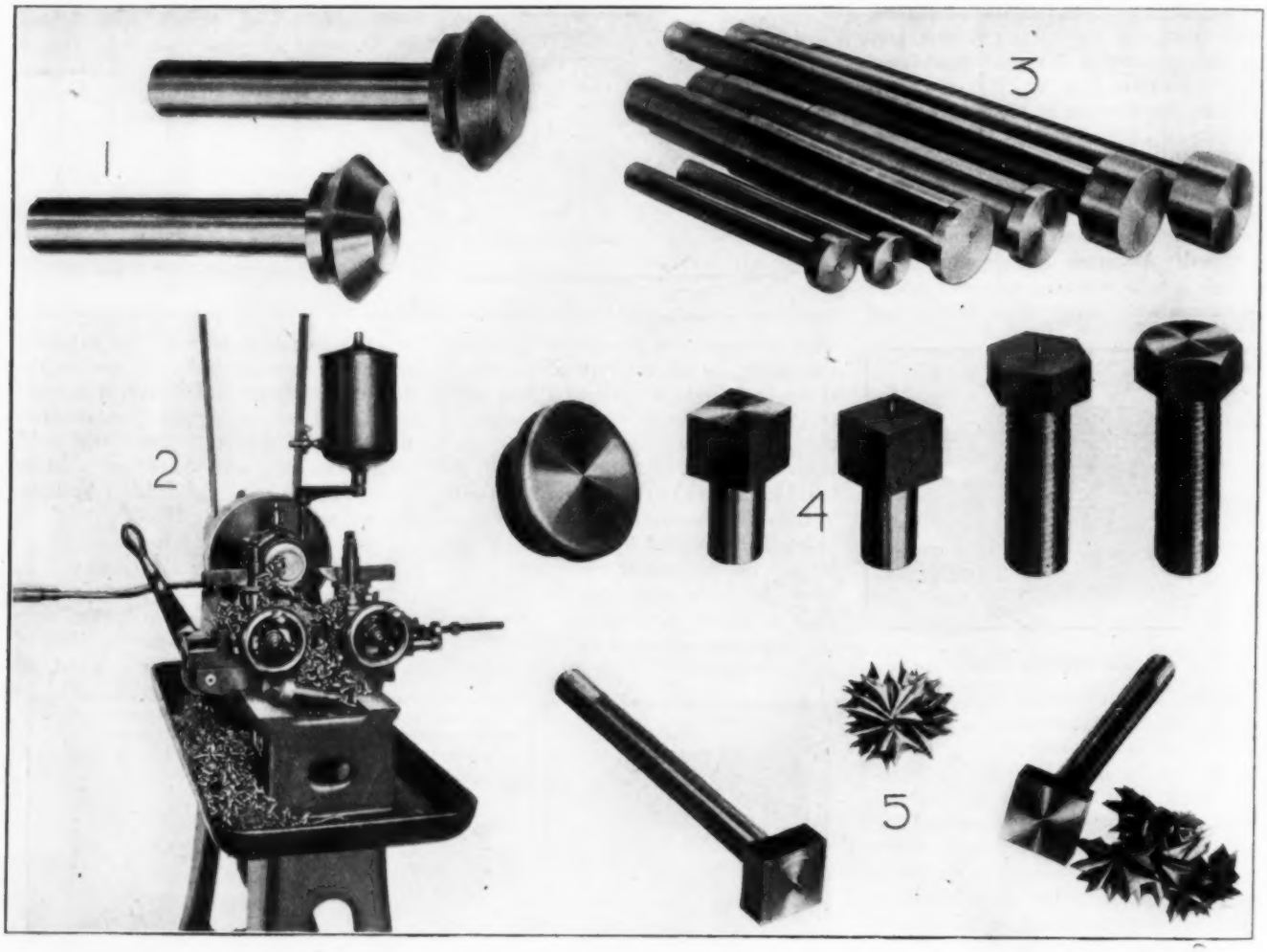
Before the days of special machinery we handled everything that was round, and sometimes other shapes as well, in the engine lathe. This included centering stock, turning, thread cutting and facing, and it was not considered good policy to take a job from one machine to another, even though we first roughed them out, then finished, threaded, etc.

We have now reached the stage where work is turned up on one lathe, such as the Lo-Swing, which only turns and has no screw-cutting attachment, then taken to a thread-cutting or milling machine and the threads cut.

In the same way the shaving machine is destined to be better known, as it can shave the ends of any kind of stock much better and quicker than it can be finished in any other way.

What the Shaving Machine Is

The shaving machine is simply a lathe with a hand-operated cross slide, adjustable rests for the tools and chuck lever at the head for operating spring or step chucks. A good view of a machine at work is shown at Fig. 2 of the accompanying illustration. Two tools are shown, one for roughing, the other for finishing; the back tool requires reversing the lathe, but as the tools are adjusted against stops, all the operator does is to chuck the work and move the cross-slide lever to complete the work. A piece of rough work is shown in the end of the lathe bed, the finishing cut being taken on the piece in the lathe.



THE SHAVING MACHINE AND SOME OF ITS WORK

In Fig. 1 two bevel-pinion blanks are shown, one rough as it came from the screw machine, the other shaved and finished in fine shape. Fig. 3 shows a collection of special bolts before and after the operation, while Figs. 4 and 5 show especially good examples of the work. The chips that come from facing a square-headed bolt are both peculiar and interesting as shown.

The shaving machine is not, however, confined to facing work, but is a forming

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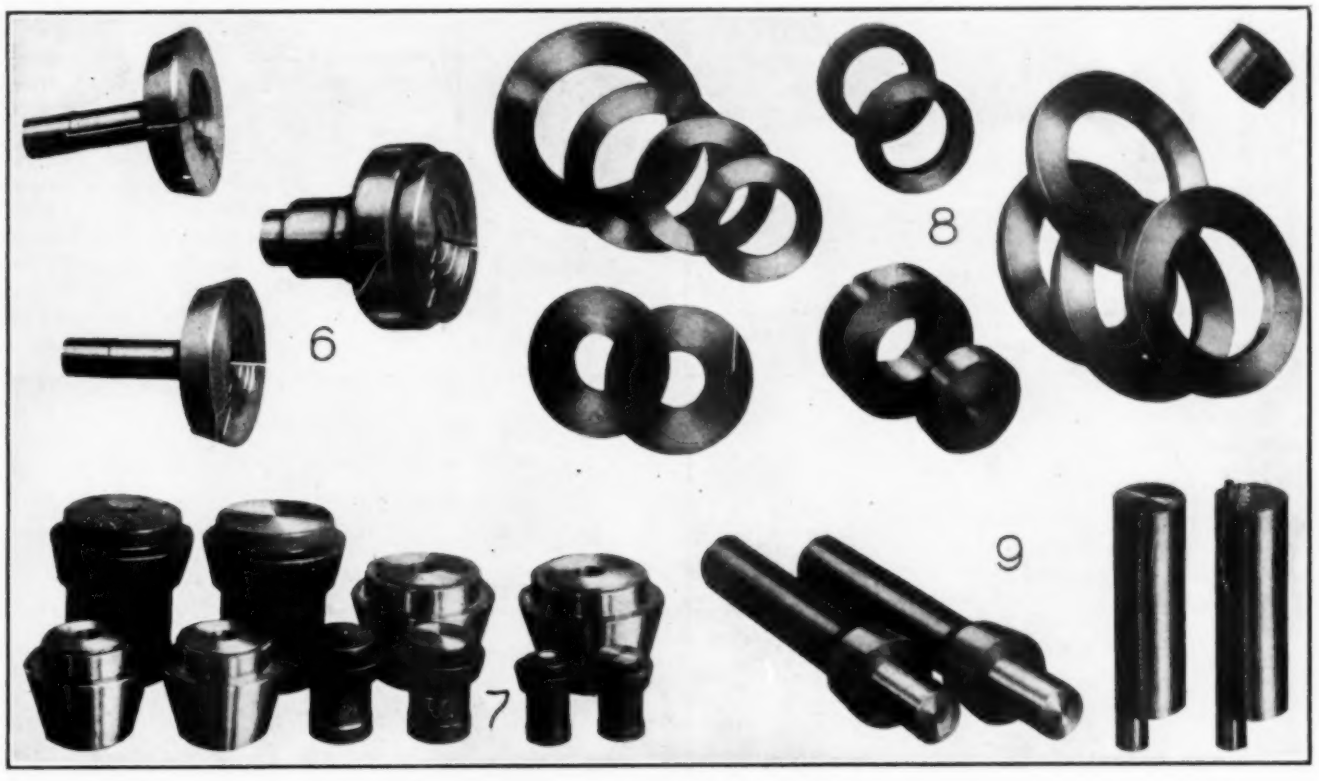
machine as well, using circular or flat tools, as desired, for rounding corners or making special shapes.

Step Chucks and Their Use

The use of step chucks adds much to the range of the shaving machine for use with such work as rings, disks and special work.

Three of these step chucks are shown in Fig 6. They are simply spring or draw chucks of large diameter, and by recessing these to the right diameter and depth, work can be firmly gripped in exactly the same place every time and the facing tools bring it to the same thickness, at the same time leaving a splendid finish and making grinding unnecessary in most cases.

Examples of thrust washers and collars faced in this way are shown in Fig. 8.



STEP CHUCKS AND SAMPLES OF WORK DONE

while Fig. 7 shows some special chuck work finished with a forming tool in a machine having a special spindle and step chucks.

That this work is not confined to facing the ends of bolts but includes any kind, such as shoulders, etc., is shown in Fig. 9, where two pieces are shown both rough and finished. The eccentric stud or projection on the piece at the right presents no difficulty whatever, being chucked true with the projection for facing that end and true with the body for the other end.

The practical usefulness of the machine is shown by the fact that the makers, the Pratt & Whitney Company, Hartford, Conn., are using 25 of them in various parts of their works, one or two being in constant use in every erecting department where there is repetition or duplicate work.

They recommend the use of a good cutting compound, such as a soda solution, and when this is done the work has a satin-like finish which makes polishing entirely unnecessary, and which cannot be improved on by an emery wheel.

This is a machine tool that deserves to be better known because of the class of work it can do and the time it can save in any shop doing duplicate work of this kind.

Turning Soft Rubber Rolls

By Walter Gribben

A soft rubber roll is not the nicest thing to turn the first time it is attempted, and a great many mechanics will tell you they should be finished in a cylindrical grinding machine, but that is an appliance that is not always found in a small shop, and those I did were finished in a bench lathe without even using the slide rest.

The rolls I have in mind were to feed up the paper in an experimental typewriter, and were about 8 inches long and a little over an inch in diameter. The roll was made of thin brass tubing, with a piece of soft white rubber hose cemented over it. This was done by first heating the brass tube enough to melt rosin, and after getting an even layer all over the tube, it was allowed to cool. Then the rubber hose was pulled over it in the same way that you get on the fingers of a tight glove, after which it was warmed up again enough to melt the rosin. This stuck the rubber on "for keeps."

Turning With Emery Cloth

In order to turn the outside of the rubber true with the pivots of the roll, it was placed in the lathe with one pivot in the wire chuck, while the other pivot ran on the tail center. This lathe had a small flat table that fitted in the hand-rest socket, and this was adjusted so it did not quite touch the rubber, as shown in sketch. Now, by placing a piece of emery cloth on the table with the business side up, and running the lathe slowly, the roll would tend to draw the cloth toward the back of the lathe, but if the cloth was held in the hand and prevented from going toward the back, the roll would then be ground off by the action of the emery cloth on the rubber. By drawing the cloth slowly forward, and allowing it to go slowly toward the back of the lathe, and also giving it a side to side movement to an extent that the width of table will admit of, the roll may be ground true in a comparatively short time.

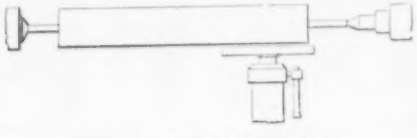
Keep Table Parallel

Of course, it is necessary that the surface of the table shall be parallel with the line of centers, and not higher on one side than on the other. After grinding as much of the roll as possible with one setting of the table, the latter may be moved along the bed without altering its hight, and in this way a roll may be ground

truly cylindrical, even if it is as long as the lathe will take in. If there is much to come off, it is a good plan not to set the table at the correct hight at first, but to take off a little at a time, making the table traverse lengthwise of the bed several times.

Keep Chips Cleared Away

One very important point is to clear away the "chips" as soon as they are formed, and this I did by holding a brush in my right hand, and constantly brushing the top of the roll immediately above where the emery cloth was at work. This is more easily accomplished if the emery cloth is not too wide, as then the brush



TURNING SOFT RUBBER ROLLS

has a smaller tract to keep clear of "chips," and it is more likely to catch them all. The particles of rubber removed by the emery cloth seem to have a tendency to cling to the rubber surface of the roll, and if allowed to do so, they are likely to produce a pit in the surface when they again pass between the emery cloth and the work. Why this should be so I do not know, but if the work is kept clean while grinding, it produces a nice uniform surface on the rubber.

Calcium has more affinity for carbon than any other metal. When introduced into a melted metal which contains carbon, it combines with it forming calcium carbide which rises to the top as a slag.—*The Brass World.*

Automatic Coin-weighing Machines

By A. L. Lambert

Accurate weighing is probably the most important of the mechanical operations required in the making of money at the United States mint. With the exception of dimes and minor coins, each individual piece must be weighed. The experience of years does not contribute any suitable method whereby large numbers of coins can be made that will weigh exactly alike. The law, cognizant of this fact, provides that money may be made that is slightly lighter or heavier than the standard. The amount of this variation is fixed and is called "tolerance." It is provided, however, that in each bag of gold containing $5000 and in each bag of silver containing $1000, the light pieces and heavy pieces must be mixed together so that they will weigh a specified amount.

The final weighing of the money has been done partially by automatic machine for years, but it has been far from satisfactory owing to the fact that the machines could not be relied upon always to do accurate work; accuracy is of prime importance in this work because it is considered a serious offense for the mint to put into circulation any money that does not conform to the weight specified by law.

As there was a need of automatic weighing machines, the officials decided to build several after their own designs at the machine shops of the Philadelphia mint; these have proved most satisfactory and it is now possible to weigh faster and more accurately than ever before.

The accompanying half-tones show one of these new machines which is now on exhibition at the Ter-Centennial Exposition at Jamestown, Va. Fig. 1 shows the front of the machine, Fig. 2 the back and Fig. 3 a scale with the coin-handling and balancing mechanism. Each of these machines is equipped with ten scales or balances, which are protected from dust and air currents by a glass cover. Each scale will weigh ten pieces per minute, thus making the output of each machine one hundred coins per minute. It is only necessary that the operator keep the ten tubes or hoppers full of coins, then each of the ten feeders will push one coin into the trap every six seconds. From the

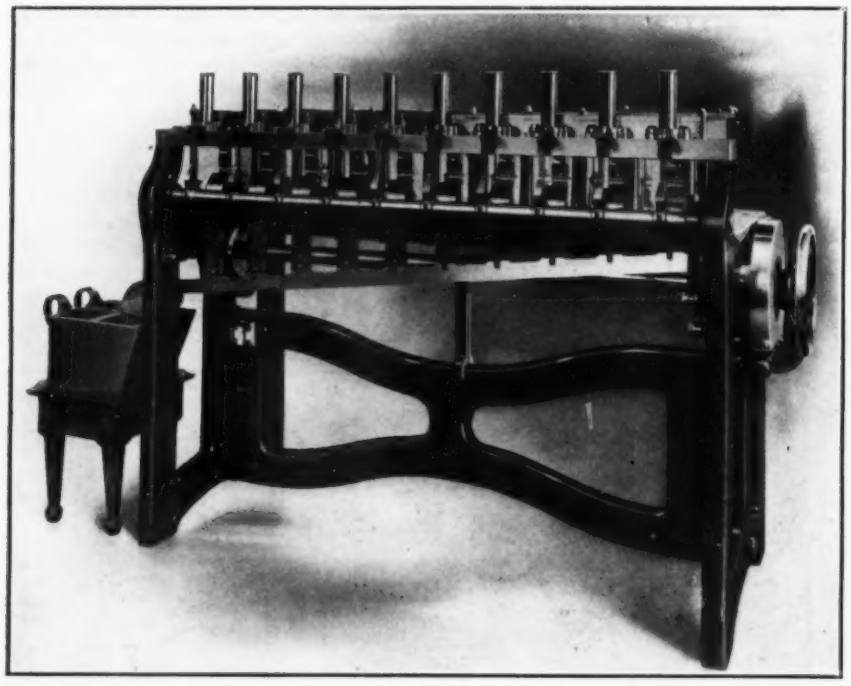


FIG. 1. FRONT VIEW OF COIN-WEIGHING MACHINE

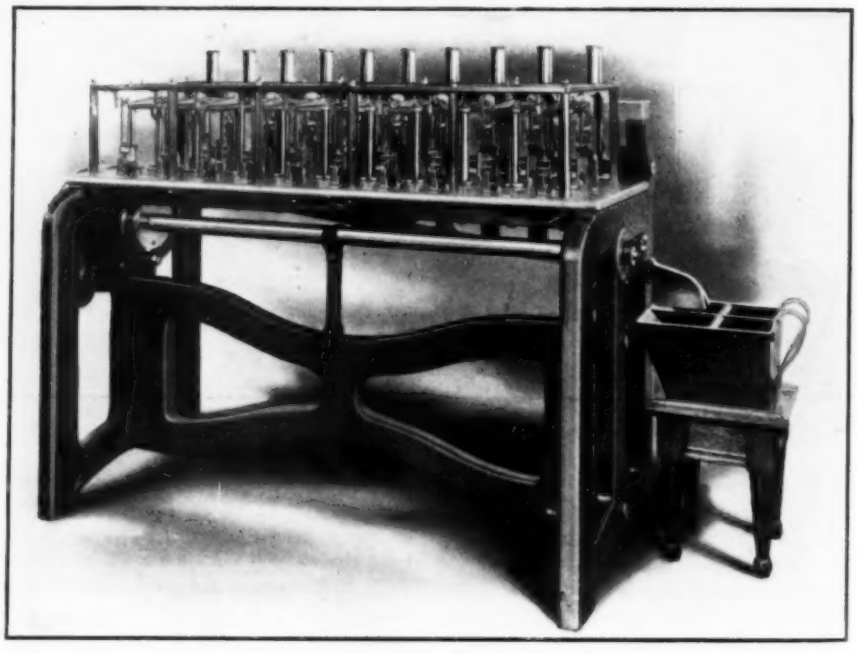


FIG. 2. REAR VIEW OF COIN-WEIGHING MACHINE

trap (referring to Fig. 3) the coins are deposited in the basket to be weighed, and thence they are discharged into spouts arranged to guide them to their respective boxes.

While these machines have been called weighing machines, they might more appropriately be termed separating machines, because the weight is arrived at by a series of separations. First, a box of coined money is separated into two lots, one of which is lighter than the standard weight while the other is heavier. The box of light money is then run through another machine of the same kind but with a weight on the pan equal to the minimum weight fixed by law for that particular denomination; then all of the coins that are lighter than this weight are thrown out as condemned and those that are heavier are called "good lights." The same is done with the coins that are heavier than standard, except that the weight on the pan is equal to the maximum weight fixed by law for this denomination; the coins that are heavier than this weight are condemned as being too heavy, while the others are called "good heavy." By weighing each coin twice, all the condemned pieces are found and all the light pieces are separated from the heavy ones. This money is kept in different boxes marked so that the person who makes up the bag for shipment can properly mix them.

Fig. 3 shows a view of one of the scales when the machine is standing at zero. In this position there is a coin in the trap and one in the basket ready to be weighed. As the shaft revolves, the leveling bar is gradually lowered until it has moved 5/32 inch. It should be noted that the removing of the bar from beneath the beam, thereby leaving the beam free to move, is the most delicate of all the scale movements. The beam is made of aluminum and is so sensitive that a 1/50-grain weight will cause it to swing when loaded with 700 grains on each end. In the old-fashioned hand scale a false release of the beam might easily be rectified, but in an automatic scale the beam must be released correctly each time, for the machine has no way of knowing whether a false movement has been imparted to the beam, and even if it had, it could not go back and try again.

The leveling bar now remains stationary until the shaft has revolved to 210 degrees, and during this time (3½ seconds) the beam has moved either up or down, according to the weight of the coin in the basket. The bar comes down and the connecting-rod, which is fastened to the front end, causes the gripper to clamp the basket firmly back against the vertical plate. When the basket is thus clamped, the leveling bar still has ¼ inch more distance to move, and as the lower end of the connecting-rod can go no farther, the telescopic joint yields and causes the discharge kicker to push the basket bottom from beneath the coin, which is discharged by gravitation into one of the spout openings. The leveling bar now rises slightly and allows the basket bottom to close again; as soon as this is done, the trap opens and allows another piece to drop into the basket. The basket is still clamped by reason of a spring in the telescopic joint, otherwise the beam would receive a severe shock when the coin drops into the basket; the rising movement of the leveling bar causes the friction fingers to touch lightly the basket and weight pan to stop any swinging action that may take place. The feeder is now returning for a new coin, which it will deposit in the trap; meanwhile the leveling bar has risen to its highest point and brought the beam to a level position ready to weigh a new coin.

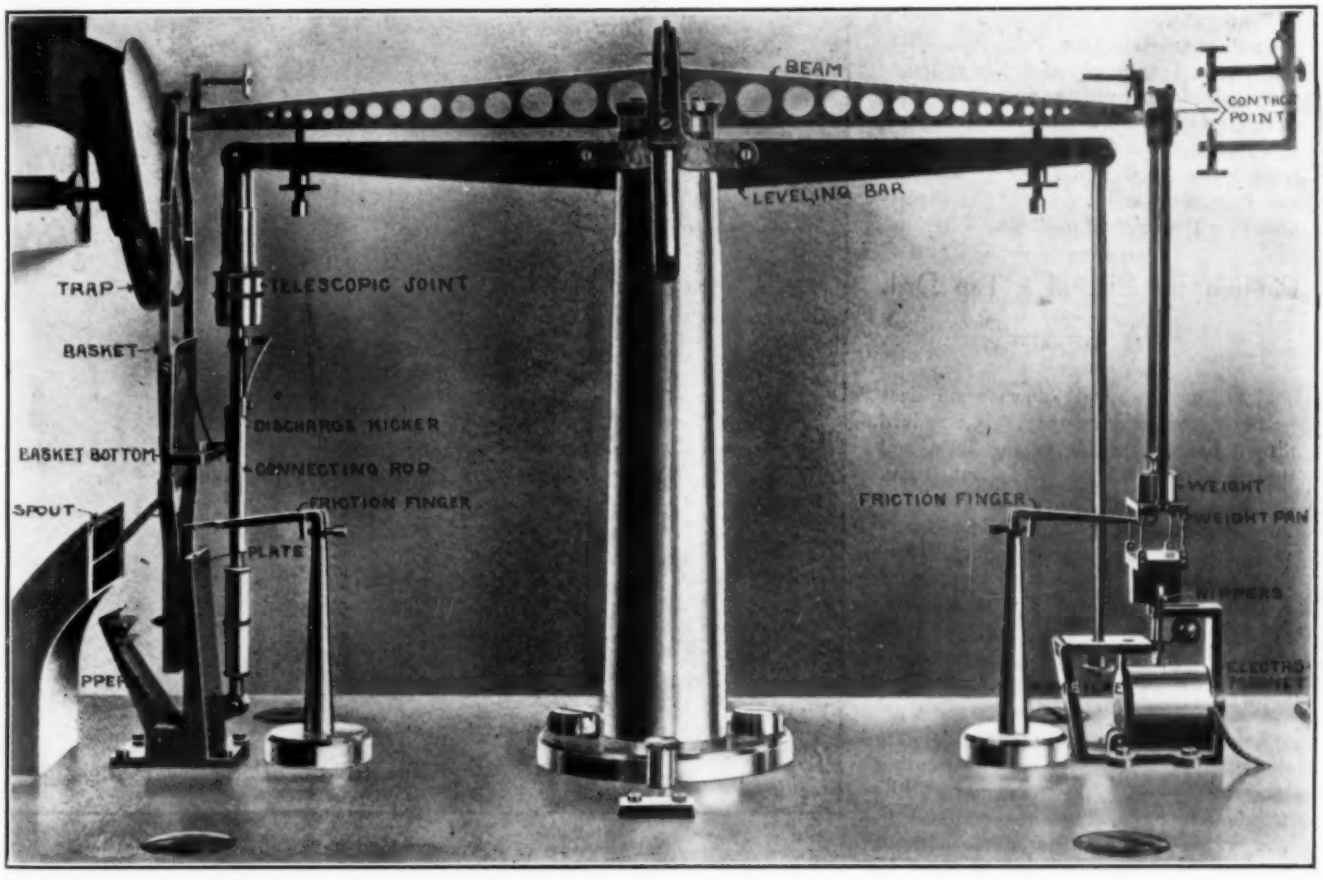


FIG. 3. ONE OF THE SCALES

One of the special features of this machine is the prevention of recoil when the beam swings either up or down. Mounted on the frame is a small electromagnet, which becomes energized whenever the end of the beam touches either of the contact points The armature of this magnet acts as a prop to a small weighted arm, which drops when the magnet is energized; the dropping of this arm closes a pair of nippers, which clasp a projection of the weight pan. The rising stroke of the leveling bar lifts the weighted

arm and it is latched up by the armature.

The planning and building of the first experimental machine occupied about one year; it was then given a test run of about six months in order thoroughly to "try out" each part of the mechanism. One of the tests the machine was put through was to have it pick out from thousands of coins of promiscuous weight certain marked pieces, the weight of which was previously fixed. The machine was required to run continuously for one day without any adjustment except that given it each morning; as a matter of fact, it was found that it could be run for several days before the scales would be appreciably out of balance. In actual practice, however, test weights are run through it each morning as a double precaution against error.

The mint is equipped with dies and special tools for manufacturing these machines, and there are now four machines in course of construction. The work is being carried on under my supervision and I designed and conducted the experiments on the original machine.

Finding the Size of a Tap Drill

By J. Schuring

Most any machinist knows some sizes by heart, for instance, that a ⅛ standard thread has 16 threads to the inch, and that a 5/16-inch hole is about right, though some tables give 9/32. Now if 16 threads per inch require 1/16 inch difference, then 8 per inch want ⅛ inch difference, the difference increasing in reversed proportion to the number of threads per inch. For a thread 20 threads per inch, the difference between size of thread and hole will be $\frac{1}{20} \times \frac{1}{8} = \frac{1}{160}$, which gives a hole $\frac{4}{160}$ inch for a ¼-inch 20-thread tap.

Taking 1/16-inch difference for 16 threads makes the holes rather large, but it seems to me enough thread, as the standard hight of a nut, equal to bolt diameter has been pronounced too high, 13 7/10 of that hight is enough to keep the thread from stripping and a tap hole in a wrought-iron body is nearly always even deeper than the bolt diameter.

It seems, therefore, safe to have the holes somewhat large, as it does away with the breaking of taps to a great extent. In hand tapping a large hole it means an easy start, and that gives a much better chance of starting the tap straight.

The estimated population of continental United States in 1905 and 1906, according to a census bulletin, was 82,574,195, and 83,941,510, respectively. Including Alaska and the insular possessions the population of the United States in 1906 was 93,182,240. The increase in population from 1900 to 1905 was 6,570,620.

An Inserted-tooth Face-milling Cutter

By Robt. R. Keith

After having placed an order with a prominent milling-machine manufacturer in the East, the question next arising was, "What kind of a face mill will we use on this machine?" The machine in question is of the duplex type; spindles independently driven and independently adjustable, vertically and horizontally. It is intended that this machine shall drive 8-inch cutters, removing from 1/32 to ⅛ inch from the surfaces of gray-iron castings, the width of these castings presented to the cutters being approximately 7⅜ inches maximum to 3½ inches minimum.

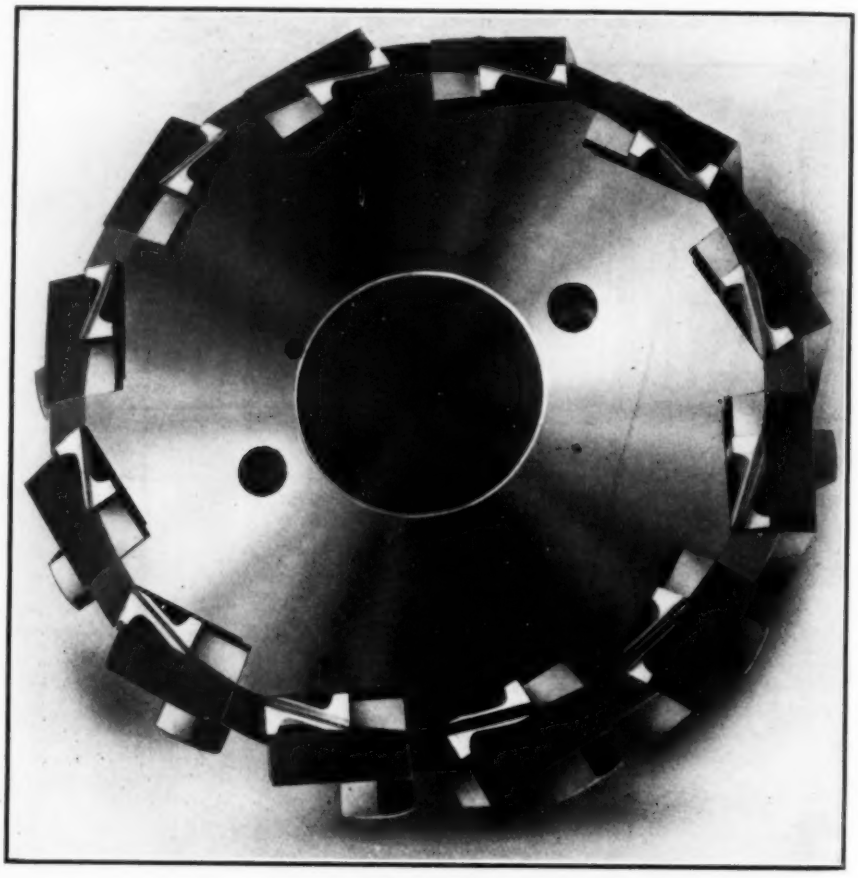


FIG. I. INSERTED-TOOTH FACE MILL

The Decision to Make Rather Than Purchase

After looking over the designs submitted by several cutter manufacturers, it was decided that face mills could be made in our own shop that would do better work than anything we could purchase, unless specially made to our design. This would seem to some as rather assuming, to say the least, and the attitude of criticism assumed toward designs of these manufacturers rather presumptuous on our part. However, we went ahead, backed by the courage of our own convictions in the matter, and designed a pair of mills, as shown in the half-tone and line cuts.

Making the Bodies of the Mills

The soft-steel forgings or blanks were obtained for each of the bodies and turned up, bored and threaded to fit the right and left-hand spindles on the machine. Chunks of cast iron were then gripped in the lathe chuck, bored, and threaded to fit snugly on the ends of the spindle of the lathe, on which they were then mounted. The rough ends of these chunks were then turned and threaded to fit the threads already in the cutter blanks, which were then finished all over, running on this cast-iron adapter. This procedure was followed out with both mills, the making of the cast-iron "adapter"—as it might be called—being necessary in order to mount the blank on its own center for the outside turning.

Pieces of steel were then turned up, threaded on one end to fit the blanks, turned down to the proper size and tapered on the opposite end to fit the hollow tapered arbor of our milling-machine indexing center. Holes were drilled and tapped out in the small tapered ends of these pieces of steel, so that we might introduce a cap screw from the back end of the milling center, and draw these studs or arbors in the indexing device snugly. This being done, the milling-cutter blank

was secured on to the threaded nose by a dowel-pin after having been screwed on tightly, and the work of milling begun.

The Cutters

The rest of the operations need no especial description, unless it might be, perhaps, the matter of grinding the cutters, which is accomplished in an ordinary cutting grinder, the cutters being ground tangentially instead of radially as usual. Particular attention is called to the steel used for the cutters, namely, ⅜x¾-inch patent Z-bar section Novo, which it will be seen requires but little grinding in order to clear the cut.

Attention is also called to the feature of giving the cutter both top rake (8 degrees) and side rake (14 degrees), most designers being satisfied with the former. After the completion of the work and the mounting of a piece on the mill for the trial cut, the time had evidently arrived for someone either to disappear or else loosen up his clothes to make room for expansion. The mills during the trial cut were running at 25 revolutions per minute, at a feed of 0.112 inch per revolution, which would mean a table feed of 2.8 inches per minute, and a cutting speed of 52.4 feet per minute, the depth of cut being approximately 3/16 inch.

Satisfactory Performance

This cut was taken without trembling, chattering or noise; and after having taken several such cuts it was evident that a somewhat slower speed would be better, and consequently this was reduced to 23 revolutions per minute, giving a table feed of 2.57 inches per minute, at which the mills are now running very satisfactorily indeed.

Not being satisfied that our expenditure in the way of time and labor on these mills had been altogether wise, a standard design of inserted-tooth mill with taper-pin binder and ¼x1-inch inserted teeth was tried out on this same machine. This mill would not take over 1/16-inch cut at the same rate of feed and speed, without chattering, and therefore quickly dulling the teeth, which were 18 in number against 12 in the mill we made. This cutter would also easily stall the machine, whereas the other mills do not seem to tax the belts seriously with our cutters. The standard cutters shove or scrape off a very fine cut per tooth, whereas our mills turned off a curly chip, as a properly ground lathe tool should do.

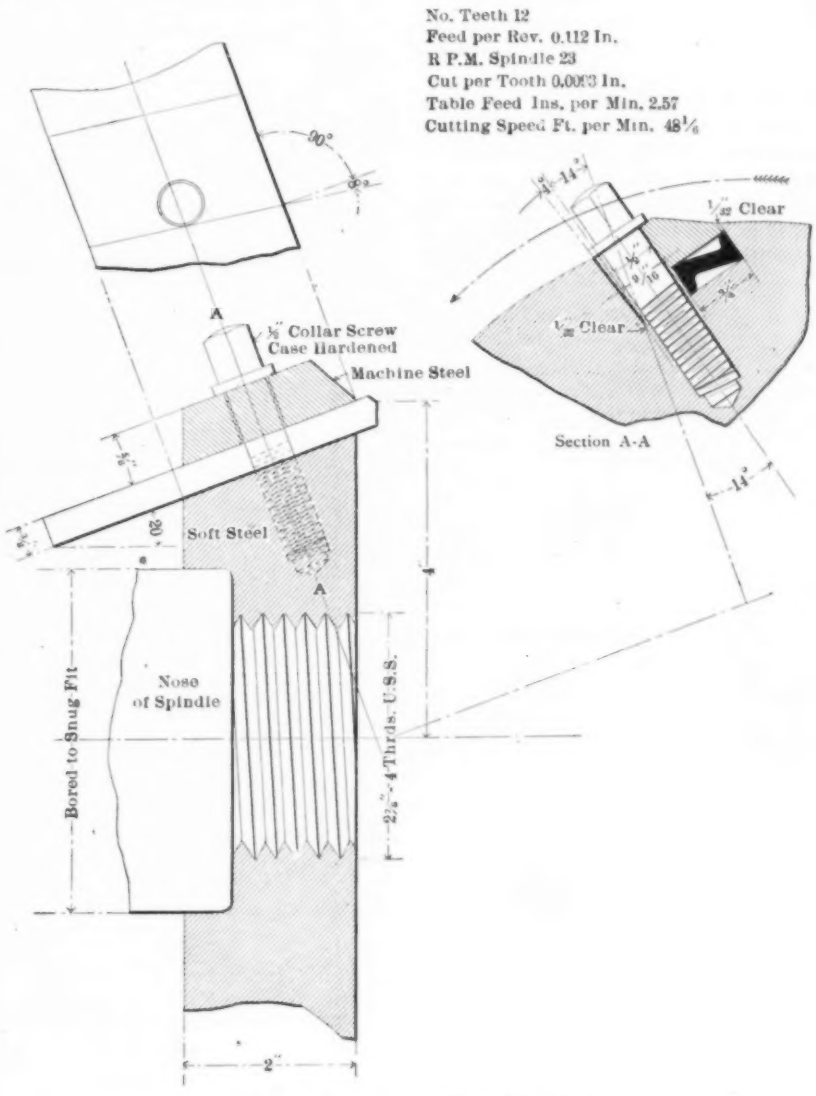


FIG. 2. INSERTED-TOOTH FACE MILL

Points of Superiority

Finally, the points worthy of consideration are the manner of wedging in the cutters, as shown in Fig. 2, the unusual size of the teeth, the unusually small number of teeth, and the extra thickness of blank in which these teeth are held, together with the feature of top and side rake, as well as clearance, which latter was ground to five degrees.

Courtesy is due the liberal policy of the management in executing this work, as well as the interest and coöperation of foreman and toolmakers.

It is now time for the woodmen to appear with their axes.

Recovery of Copper and Brass and Other Metals from Scrap

A comparatively new industry has sprung up in the refining of non-ferrous scrap metal and the present high prices asked for all metals of this class has led to unusual activity in the scrap market. Scrap producers are anxious to realize on their waste metal and competition is keen for the purchase of raw material by the refiners. Copper is getting its due share of attention, and some care is necessary now in handling the ever-increasing traffic in copper and brass scrap.

Brass and other alloy scrap is recovered by remelting in crucibles with new metal. Fine particles of brass, such as occur in ashes, skimmings and sweepings, are recovered by a system of washing and jigging. Concentrates obtained from jigging processes are smelted in a reverberatory furnace, or they are melted down in crucible or oil-burning furnaces and cast into ingots.

Copper scrap is treated differently according to the character of the material. The copper may be in the metallic state, as in trimmings from copper sheet, borings, grindings, punchings, etc., or it may exist in chemical combination with some other element, as in copper scale or blue vitriol.

Metallic scrap copper may be melted in reverberatory furnaces of similar design to those used in the copper-mining districts. The slag skimmed off consists of impurities originally contained in the charge, and combinations of copper with oxygen and the fire-brick lining of the furnace. The slag may contain from 30 to 70 per cent. copper, which is recovered by smelting in a cupola or a small round water-jacketed blast furnace.—*Copper and Brass.*

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Arithmetical Short-cuts

With all the new ways of multiplying and of proving calculations, in other words, the short cuts that have been given by various contributors, how many readers of the AMERICAN MACHINIST are applying them in every-day work?

I haven't a doubt that every one of them may be helpful to the man who learns it and uses it enough so that it comes as naturally to him as the multiplication table which was drilled into him in school, but unless you use these things right along, they are apt to be more trouble than they are worth. The same holds good with logarithms or the slide rule.

The average mechanic does not use arithmetic enough to pay him for the time taken to memorize these short cuts, and unless he gets them thoroughly in his mind they are apt to get him into trouble.

Draftsmen and those making frequent calculations ought to find them useful, but I have got over learning short cuts unless I feel pretty sure I shall use them enough to make it an object to do so.

F. H. C.

Reading "Arithmetical Short-cuts," at page 539, I fail to see where the inversion of the formula $a^2 + 2ab + b^2$ takes place. The method used is simply the expansion of $(a + b)^2$ by the binomial theorem. Whether it can be done mentally or not is only a matter of memory.

Take the same figures that your correspondent uses, 37^2. He divides this into 7 and 30, calling $7 = a$, $30 = b$. The mere fact that in practice the ciphers are cut off from the partial products does not alter the fundamental theorem.

Carrying out the same example, 37^2, as it should be, it will appear graphically as follows:

$$\begin{array}{r} 37 \\ 37 \\ \hline 7 \times 7 = \quad 49 = a^2 \\ 2 \times 30 \times 7 = 420 = 2\,b\,a \\ 30 \times 30 = 900 = b^2 \\ \hline 1369 \end{array}$$

This, expressed algebraically, is

$$a^2 + 2\,b\,a + b^2,$$

which is only a transposition of one letter of the middle term, and not an inversion of the expression. JOHN E. HICKS.

A Box Tool with a Supporting and Gaging Bushing

A box tool for screw-machine work turned to a shoulder, as some screws, studs and pins, or any class of such work having a similar turning operation, is illustrated in Figs. 1, 2 and 4. The cutter is made of square stock ground to a diamond shape on the cutting end. It is set to cut from the top of the bar, as it is possible to take heavier cuts in this way than with tools commonly known as side-cutting tools.

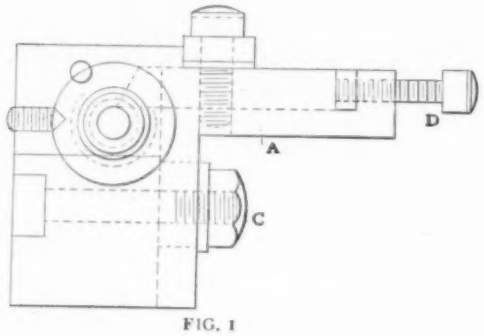


FIG. 1

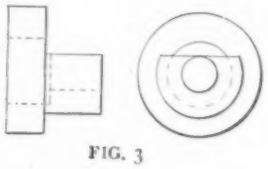


FIG. 3

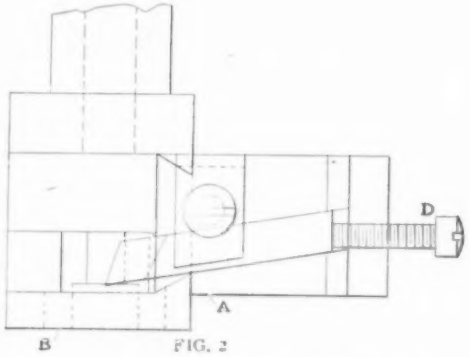


FIG. 2

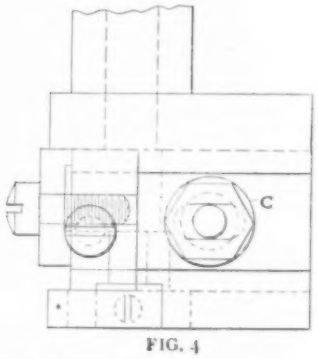


FIG. 4

A BOX-TOOL WITH A SUPPORTING BUSHING

dowel pin and held by a headless set-screw. The hole through it is of the size to which the stock is to be turned plus a little clearance, say 0.252 inch for a turning size of ¼ inch; the counterbore is the diameter of the stock to be used, with an amount of clearance determined by its character. A milling cut is taken across this bushing just breaking into the smaller hole, and cutting a short distance into the larger one (see Fig. 3). It is then hardened and ground and fixed in position in the holder, as shown at *B* in Fig. 2.

This illustration also shows its location with reference to the cutter. It is obvious that if the cutter is set to rest upon this bushing it will turn the stock to the diameter of the smaller hole, while the bushing will act as a support for the turned diameter. The larger hole acts as a guide; the amount of clearance over the nominal diameter of the bar is—as I have stated—determined by the kind of stock used.

The center line of the holder shank is above the center line of the bar, as shown by the illustrations, to give an ample bearing surface to the dovetailed cutter slide *A*. The slot in this piece *A* is machined at an angle with the center line of the holder to give a proper cutting angle to the cutter. This slide is adjustable in a vertical plane and has a clamping screw *C*, and a screw for breaking up the cutter, lettered *D*.

The front of the holder is bored and recessed for the cast-steel bushing shown by Fig. 3. This bushing is located by a

One advantage of this tool is that the bushing is a gage or check on the turned diameter, and the cutter is easily adjusted for minor changes in setting. The best

result is obtained from high-speed steel cutters. C. PETITJEAN.

L——, England.

A Problem in Laying out a Gear Train

The problem stated by Dynamic at page 712, Vol. 30, Part 1, is a comparatively common one, and the particular form he gives is the simpler of the two in which it may appear.

SOLUTION OF THE CASE WHERE THE INTERMEDIATE GEAR CENTER IS EQUIDISTANT FROM THE OTHER TWO

Taking it up from the mathematical side, we have as stated, referring to Fig. 1, the lengths AB, BC, CD and AD given, and we wish to find the length BE. First join AC and from B draw BF perpendicular to AC and meeting that line in F.

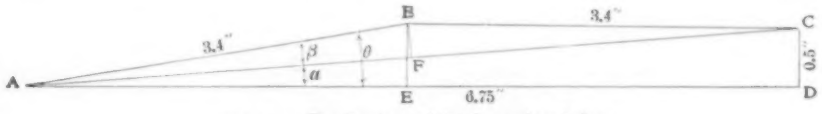


FIG. 1. The Centers of the Gears located as Stated in the Original Problem.

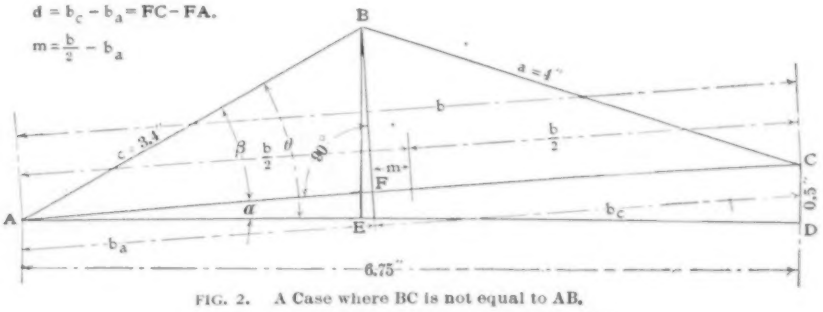


FIG. 2. A Case where BC is not equal to AB.

A PROBLEM IN LAYING OUT A GEAR TRAIN

Now calculate the length AC, which is

$$\sqrt{6.75^2 + 0.5^2} = 6.76849$$

As $AB = BC$, AF and FC are the same length $=$

$$\frac{6.76849}{2} = 3.384245.$$

We can now find the magnitude of the angles CAD and BAF;

$$tan.\ CAD = \frac{0.5}{6.75} = 0.074074,$$

and $CAD = 4°\ 14'\ 11''$;

$$cos.\ BAF = \frac{3.384245}{3.4} = 0.9953661,$$

and $BAF = 5°\ 31'\ 4.5''$. Angle $BAE = BAF \pm CAD = 9°\ 45'\ 15.7''$, and $BE = 3.4 \times sin.\ 9°\ 45'\ 15.7'' = 0.576043$, the length required.

SOLUTION OF A CASE WHERE THE INTERMEDIATE GEAR CENTER IS NEARER TO ONE THAN TO THE OTHER OF THE OUTER GEAR CENTERS

Perhaps Dynamic or some other reader will have occasion to attack a similar problem in which the lengths AB and BC are unequal, so we shall solve one here. Referring to Fig. 2, let $AB = 3.4$ and $BC = 4$. As in the previous case calculate $AC = 6.76849$. We must now find the length AF, to do which we use the theorem: A line drawn from the apex of a triangle perpendicular to its base divides the base into two parts, the difference between which equals the product of the sum and difference of the sides divided by the base.* Thus

$$FC - AF = \frac{(3.4 + 4) \times 0.6}{6.76849} = 0.65598,$$

and

$$AF = \frac{6.76849 - 0.65598}{2} = 3.05625.$$

$$Cos.\ BAF = \frac{3.05625}{3.4} = 0.898897,$$

and $BAF = 25°\ 59'\ 11.5''$. The angle BAE is thus $25°\ 59'\ 11.5'' + 4°\ 14'\ 11'' = 30°\ 13'\ 22.5''$ and $BE = 3.4 \times sin.\ 30°\ 13'\ 22.5'' = 1.7114$. N. GINEER.

[The relation employed in the foregoing paragraph may also be derived from the theorem that the difference of the squares of the sides meeting at the vertex equals twice the product of the base of the triangle by the distance from the middle point of the base, to the foot of the perpendicular to the base from the vertex, that is, $a^2 - c^2 = 2bm$,

or $$\frac{a^2 - c^2}{b} = 2m,$$

which is

$$2\left(\frac{b}{2} - b_a\right) \text{ or } b - 2b_a.$$

But since

$$b_a = \frac{b - d}{2},\ b - 2b_a = d,$$

hence

$$d = \frac{a^2 - c^2}{b}.$$

$$b_a = \frac{b - d}{2} = \frac{b^2 - a^2 + c^2}{2b}.$$

$$cos.\ BAF = \frac{b_a}{c} = \frac{b^2 - a^2 + c^2}{2bc},$$

or if for b^2 we write

$$\overline{AD}^2 + \overline{CD}^2$$

we have:

$$cos.\ \overline{BAF} = \frac{\overline{AD}^2 + \overline{CD}^2 - \overline{BC}^2 + \overline{AB}^2}{2 \times AC \times AB}$$

Out of several letters received giving solutions to this problem, the above is published, since it contains a solution for the general case and also for the particular case where $a = c$; and, moreover, the numerical value of the answer is worked out, which some of the others did not do, merely giving methods and formulas. Solutions for the general case have been received from Alpha, F. W. B., Joseph Fuchs, J. R. Eldred, E. D. Gagnier, and Letsid; and for the case where $a = c$, from Detroit, Charles J. Wood, V. E. W., and M. R. Kavanagh. All of these are worked by geometry and trigonometry upon the same principles as employed in the letter of N. Gineer. Another correspondent, Walter Gribben, sends, in addition to the solution of the special case, a method for solving the general case, but not worked out numerically; the portion of his letter containing this follows; a somewhat similar method is given in a communication from A. J. W., which is published as illustrating the use of logarithms in doing the work.—ED.]

ANOTHER METHOD OF SOLVING THE GENERAL CASE

In the event of AB and BC not being equal, the angle BAC would have to be determined by the formula for solving a triangle when all three sides are given, which is

$$tan.\ \tfrac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}},$$

where A = required angle;
a = side opposite;
b and c = sides adjacent to A;

$$s = \frac{a + b + c}{2}.$$

WALTER GRIBBEN.

Referring to an article at page 712 of the AMERICAN MACHINIST, asking for a correct mathematical solution of a problem in laying out a gear train, I submit the following, which is a general solution for all cases similar to the problem given.

It may be mentioned that a full-size layout as accurate as is practicable with which to check one's figures approximately is a good plan and might perhaps save considerable amount of time and work in case an error were made in the calculation.

There are various ways of solving by trigonometry the problem given. The following method I have found very convenient and practically correct when the

*See note at end of letter.—ED.

calculation has been made as accurately as the logarithmic tables will allow.

SOLUTION OF THE GENERAL CASE

In the figure*, A, B and C are the gear centers. In our example are given the center distances AB and BC, also the sides AD and CD of the right-angled triangle ACD, to find BE and AE.

Applying trigonometrical formulas, we have:

$$tan.\ \alpha = \frac{CD}{AD} \qquad (1)$$

$$AC = \frac{AD}{cos.\ \alpha}. \qquad (2)$$

To find the angle B in the triangle ABC we use the trigonometrical formula:

$$sin.\ \frac{\beta}{2} = \sqrt{\frac{(S-AB)(S-AC)}{(AB)(AC)}}, \qquad (3)$$

where

$$S = \frac{AB + AC + BC}{2} \qquad (4)$$

We now have the angle $\theta = \alpha + \beta$, and we find in the right-angled triangle ABE:

$$BE = AB \times sin.\ \theta, \qquad (5)$$

and

$$AE = AB \times cos.\ \theta. \qquad (6)$$

By substitution in our example, in which $AB = 3.4$ inches, $BC = 3.4$ inches, $AD = 6.75$ inches and $CD = 0.5$ inch, we have:

$$tan.\ \alpha = \frac{0.5}{6.75} = \frac{1}{13.5}. \qquad (1)$$

Applying logarithms, we find:

$$\begin{aligned} colog\ 13.5 &= 8.8696662 = log.\ tan.\ \alpha; \\ \alpha &= 4^\circ\ 14'\ 11.02''. \end{aligned}$$

$$AC = \frac{6.75}{cos.\ \alpha}. \qquad (2)$$

$$\begin{aligned} log.\ 6.75 &= 0.8293038 \\ colog.\ cos.\ \alpha &= 0.0011882 \\ log.\ AC &= 0.8304920; \\ AC &= 6.768494. \end{aligned}$$

$$S = \frac{3.4 + 6.768494 + 3.4}{2} = 6.784247. \qquad (4)$$

$$sin.\ \frac{\beta}{2} = \sqrt{\frac{3.384247 \times 0.015753}{3.4 \times 6.768494}}. \qquad (3)$$

$$\begin{aligned} log.\ 3.384247 &= 0.5294621 \\ log.\ 0.015753 &= 8.1973633 \\ colog.\ 3.4 &= 9.4685211 \\ colog.\ 6.768494 &= 9.1695080 \\ log.\ sin.^2\ \frac{\beta}{2} &= 7.3648545 \\ log.\ sin.\ \frac{\beta}{2} &= 8.6824272.5 \end{aligned}$$

$$\begin{aligned} \frac{\beta}{2} &= 2^\circ\ 45'\ 32'' \\ \beta &= 5^\circ\ 31'\ 04'' \\ \alpha &= 4^\circ\ 14'\ 11'' \\ \theta = \alpha + \beta &= 9^\circ\ 14'\ 15'' \end{aligned}$$

$$BE = 3.4 \times sin.\ \theta \qquad (5)$$

$$AE = 3.4 \times cos.\ \theta \qquad (6)$$

*Refer to figure accompanying letter of N. Gineer.—ED.

$$\begin{aligned} log.\ 3.4 &= 0.5314789 \\ log.\ sin.\ \theta &= 9.2289677 \\ log.\ BE &= 9.7604466 \end{aligned}$$

$$\begin{aligned} log.\ 3.4 &= 0.5314789 \\ log.\ cos.\ \theta &= 9.9936759 \\ log.\ AE &= 0.5251548 \end{aligned}$$

$$BE = 0.5760 \text{ inches}$$

$$AE = 3.3509 \text{ inches}$$

SOLUTION OF THE SPECIAL CASE

For the special case given, where the center distances are the same, I submit below a simpler solution to find the angle β, instead of using formulas Nos. 3 and 4.

We have $AB = BC = 3.4$ inches, therefore ABC is an isosceles triangle, and in the right-angled triangle ABF;

$$cos.\ \beta = \frac{AF}{AB} = \frac{\frac{AC}{2}}{AB} = \frac{6.768494}{2 \times 3.4} = \frac{6.768494}{6.8}.$$

$$\begin{aligned} log.\ 6.768494 &= 0.8304920 \\ colog.\ 6.8 &= 9.1674911 \\ log.\ cos.\ \beta &= 9.9979831 \end{aligned}$$

$$\beta = 5^\circ\ 31'\ 04''.$$

A. J. W.

A complete analytical solution, giving the distance BE directly, could be arranged by placing coördinate axes parallel to AD and DC, then setting up the equations for circles described about centers A and C with radii c and a, respectively, and solving for the intersections of the two circles. This, however, would be too awkward for use, except where mathematical accuracy is desired for its own sake.

SMITH FARIS.

Box Tools for Small Taper Pins

On page 402 Tapers proceeds to describe a set of cams for the Brown & Sharpe automatic screw machine. These cams are used for the movement of tools in the turret, front and back cross slides for the production of taper pins and work of a similar nature. He also describes an excellent box tool for making taper pins for use in this machine.

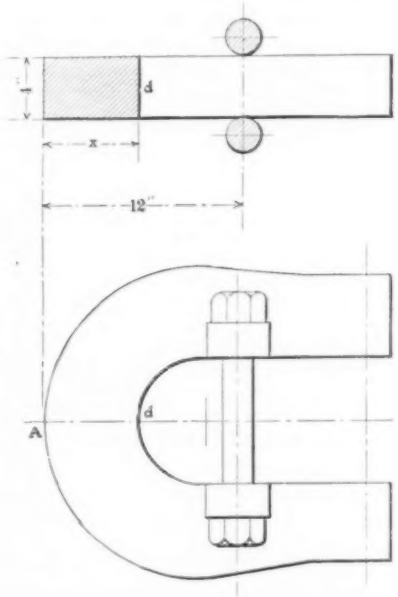
But poor Tapers had the misfortune not to call a spade a spade. Two English cousins of his proceed to rake him fore and aft, at pages 739-740, about the layout of the cams he has described, and Auto Operator sends along a drawing of a set of cams which are identical to a hair with those which Tapers describes!

It is clear to one familiar with this machine and the work it turns out, that the cams could hardly be used in any other way than that for which they are designed. M. E. Chanic and Auto Operator are clearly familiar with the subject; while Tapers is a little off the track when he describes his sketch, he was there with the goods when you look at the drawing.

RUSSELL.

Designing a Press Frame

At page 677, Vol. 30, Part 1, Con Wise presents an interesting problem and three solutions of same. In his first solution we find an erroneous method of procedure which might require considerable discussion to convince everyone that it is wrong. In finding his neutral axis for a cross-section considered as a beam, Con Wise injects the relative *strengths* of the materials of which the beam is made up, and where one material is five times as strong as the other in tension (can anyone tell why he might not have considered compressive strength instead?) he considers it to have five times its real area or value in ascertaining the location of the center of gravity or neutral axis. It is obviously wrong to use the strength of the materials



DESIGNING A PRESS FRAME

in this connection for the fundamental formula for the stress in a beam, and for the application of which we find the neutral axis; the stress in any fiber of the material is directly proportional to its distance from the neutral axis—which neutral axis passes through the center of gravity of the cross-section.

So far as I know, the tensile strength of a metal has nothing to do with its gravity, and hence in ascertaining the position of the neutral axis the method employed in the second and third cases is correct.

The method employed in Fig. 6 by Con Wise is all right for reducing the cast-iron section that is in tension. Of course for a given allowable stress in the steel bar the applied stress reduces as we cut away this metal from the throat of the bend, for up to a certain point (as will be found below) the neutral axis moves toward A, making the lever arm greater; hence, for the same bending moment the stress is less.

Considering that we wish to have none of the cast iron in tension (due to bending moment), we find the amount of metal that should be cut away as follows:

Referring to the figure, we wish to find the distance x such that the center of gravity is at d, making the neutral axis pass through that point. The value x can best be obtained by simply equating the moments of the rectangular area and the two circles about the desired neutral axis. Thus:

Area of rectangle $= 4\ x$.

Moment of rectangle about $d = 4\ x \times \frac{x}{2} = 2\ x^2$.

Area of steel bars (in which $D = 2$ inches) $= 2 \times \frac{\pi D^2}{4} = 6.28$ square inches.

Moment of round bars $= 6.28\ (12 - x)$.

Equating the two moments, we have:

$$2\ x^2 = 6.28\ (12 - x);$$
$$x^2 = 37.68 - 3.14\ x;$$
$$x^2 + 3.14\ x - 37.68 = 0.$$

Adding 40.14 to both sides of this equation to make a perfect square, we get:

$$x^2 + 3.14\ x + 2.46 = 40.14;$$

extracting square roots:

$$(x + 1.57)^2 = 40.14,$$
$$x + 1.57 = 6.33,$$
$$x = 4.7 + \text{ inches},$$

which is the amount of cast iron we must have in order that the neutral axis shall pass through d.

F. H. Neely.

If Con Wise really wishes an answer to the questions with which he finishes his article on pages 677 and 678, Vol. 30, Part 1, he must give more data.

How About the Section Near the Top of the Frame?

As far as the throat of his punch frame is concerned, it is much stronger than a section through the top of the frame. Consider the section where the bolts are fastened. As there are no dimensions given, we will assume it is the same size as the throat, i.e., 4x8 inches. It is not likely to be larger than this.

The moment due to 60,000 pounds $(P = 59.775) = 480{,}000$ inch-pounds. $M = p\ z$, where p is the stress and z the section modulus.

$$480{,}000 = p\ (\tfrac{1}{6} \times 4 \times 8^2) = 42.6\ p;$$
$$p = 11{,}000 + \text{ pounds.}$$

which is too high for cast iron.

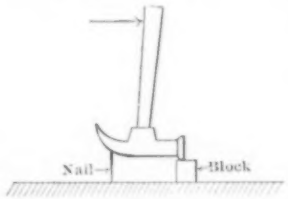
Con Wise's Comparisons Not Sufficiently Clear

There are several inconsistencies in his article which need explanation. In the description of Figs. 3 and 4 he begins his "analysis upon the assumption of a *steel* frame," and finds a new gravity axis. He then goes on in the next sentence, line 16, column three, page 677, under the above heading: "Here I was, then, with a prospect of the *cast iron* being divided," etc. In the sentence beginning on line 31 under the same heading Con Wise says: "At $t\ u$ the stress (tension) represented scales 5260 pounds, or more than the allowable tension for *cast iron*." If the frame is considered as *steel*, why does he care if the tension does run over that allowable for cast iron?

Exception Taken to Mr. Nickel's Assumptions

This, however, is beside the point. The first error lies in the article by Mr. Nickel, on page 813, Vol. 29, Part 2, which is referred to by Con Wise. In Mr. Nickel's article, page 813, second column, fourth line, he begins with the words, "Let Fig. 1 represent a beam," etc., and continues, line 7, "and let us for convenience consider the forces and sections concentrated in points A and B. The neutral axis will then be midway between A and B." If the forces are *concentrated* at A and B, an axis *anywhere* between A and B will experience neither compression nor tension, and hence will be a "neutral axis."

To make a little plainer the fallacy of the assumptions of concentrated forces and sections, consider the following case:



DOES THE POSITION OF THE "NEUTRAL AXIS" DEPEND UPON THE MATERIAL OF THE BLOCK?

Take a carpenter's hammer of the ordinary style and pull a nail part way from a board. Now put a block under the peen of the hammer. Here we have a concentrated compression in the block and tension in the nail. A given amount of push on the hammer handle will draw the nail from the board, no matter whether the block is of wood or cast iron.

From this it is seen that, considering concentrated loads and sections, the neutral axis does not shift as indicated by Mr. Nickel; for, if it did, it would take more push on the hammer handle to draw the nail if we used a cast-iron block under the hammer peen than if we used a wooden block.

The Air Subjected to Tensile Stress!

The second error is in Con Wise's assumption that the line $f\ c$ in his Fig. 2 shows the variation of stress through the punch frame and rods. If it does show the variation of stress, the air in the gap between the bolts and the frame must be stressed considerably beyond its elastic limit.

Con Wise's Methods Inconsistent with the Common Theory of Flexure

The third error is in the application of the formula $M = \frac{p\ I}{e}$ to the case in question. In Church's "Mechanics of Engineering" (1904 edition), pages 244 and 245 give the assumptions under which the above formula is developed. One of these assumptions is that the material is in the form of a homogeneous prism or *solid* with variable cross-sections, when the cross-sections are similarly situated as regards a central straight axis.

The case in question is not a homogeneous prism, neither is it a solid in the sense used above. I hope that I have made myself clear and that the suggestions will be of some service to Con Wise.

Wilbur C. Searle.

Con Wise gives your readers a very interesting problem to solve at page 677, Vol. 30, Part 1. As I have recently had a similar case to solve in connection with the staybolt fitted to automobile live axles, I think perhaps I may be able to shed a little light upon the subject.

Con Wise's Bolt Arrangement May Do as Much Harm as Good

Broadly speaking, the answer to the problem depends on how tightly the staybolt in the press frame is nutted up. If a mechanic of the "strong i' th' arm but weak i' th' head" type has the job, he may be able with the design shown to break the frame in the first instance before it has the chance of performing any useful function, by pulling the bolt till the frame parts in tension at the extreme outer fibers; at the same time it is evident that it is necessary to put a quite considerable tension on the bolt if it is to be of any use in assisting the frame. If the bolt is expected to relieve the frame of all tensile stress when in use, it will be necessary to nut it up until it puts a bending moment on the frame when at rest equal to but in an opposite direction to the bending moment produced by the punching pressure. It now becomes evident that the bolt itself under this condition will put as much stress on the frame when out of use as the punch press would when in use; obviously this will not do.

Remedying the Trouble by Means of a Distance Piece

I would therefore suggest that, if it is practicable, a distance piece should be fitted between the lugs to take the pressure produced by nutting up the bolts and therefore relieve the frame of the load. This distance piece should be of as big a section as convenient in order that it may be rigid, and I would make it an easy sliding fit both upon the bolt and between the lugs when fitted in place before the bolt strain is put on; I would then nut up the bolt as tight as possible short of straining* or breaking it.

The Stresses with This Arrangement

As the frame is, under these conditions, entirely free from tensile stress, the re-

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*We presume this means that the elastic limit is not to be passed.—Ed.

sistance figure of the section becomes a triangle with the apex cut off as shown in Fig. 2. The center of gravity of the resistance figure is 3.33 inches from the extreme edge. The center of resistance is therefore 8.66 inches distant from the bolt, and, with a punching pressure of 40,000 pounds, the pressure at the center of the resistance figure is 37,000 pounds and the tension on the bolts is 77,000 pounds due to the load, plus whatever excess tension was initially given to the bolts. This works out at 1610 pounds per square inch stress in compression on the extreme fibers, and if the bolts have an effective area at the bottom of the thread of about 75 per cent. of bolt area, the stress in the

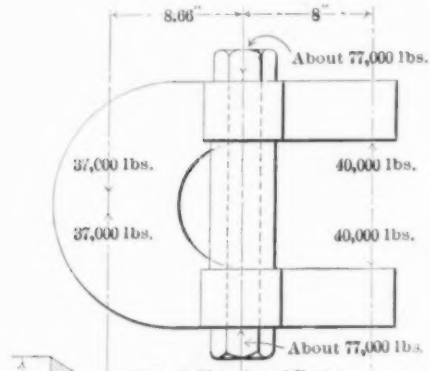


FIG. 1 Elevation of Frame with Distance Pieces

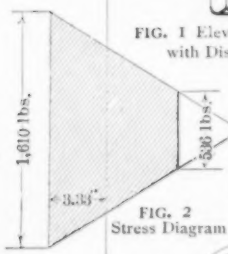


FIG. 2 Stress Diagram

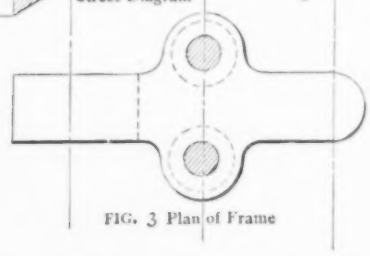


FIG. 3 Plan of Frame

A QUESTION IN DESIGNING A PRESS FRAME

bolts will be about the same, i.e., 1610 pounds.

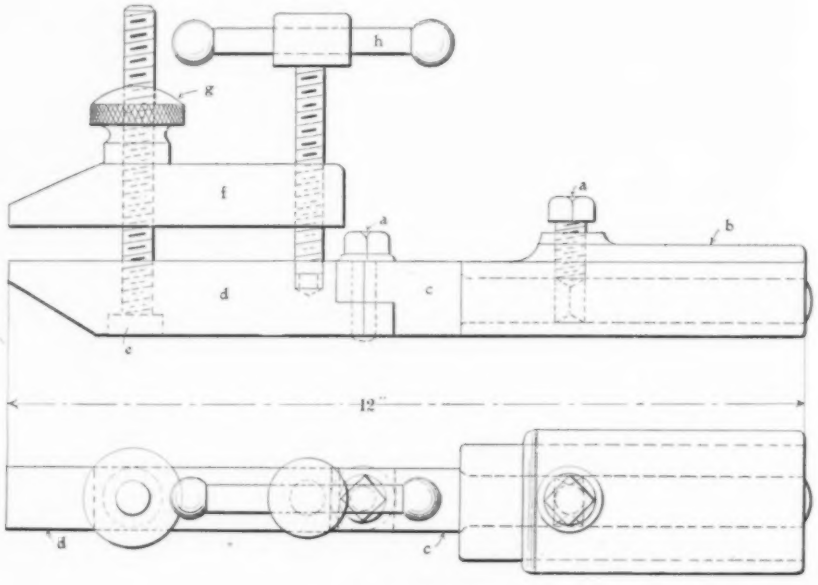
If, when fitted as suggested, and the punching pressure applied, the distance piece remains gripped sufficiently to resist turning on the bolt when lightly pulled with pipe tongs, you may be sure that no tension is on the fibers of the frame; this is suggested as a practical test. All the foregoing does not answer Con Wise's query in his last paragraph, but although I have not gone into the figures, I do not imagine there is a great deal of difference between them, though I should expect the first design to be slightly the stronger one.

V. L. BARFORD.

London, England.

A Diemaker's Clamp

I came across a diemaker's clamp which I think is worth while. By loosening the set-screw *a a* it can be set in any position required without taking it out of the clamp or bench vise. The holder *b* has two ribs, one on each side, so it will rest on top of the jaws of the bench vise. In the center is fitted the end joint *c* held in a groove, when in proper position, by a set-screw *a*. Connected with the joint is the lower jaw *d*. This is also held in position by a set-screw. The other end is counterbored for the screw head *e;* the latter is a driving fit. In the upper jaw, *f* is drilled and tapped rather loose for the screw *e*. In operation adjust the nurled nut *g* to your work and tighten up by using the handle *h*. For light work the set-screws are clamped only hard enough to keep the joint and the bearing in the holder *b* from turning.



A DIEMAKER'S CLAMP

R. A. ALMOND.

Technical Education from a Professor's Standpoint

"Perseveri" gives me credit for being amusing "in parts," in his letter on page 813. This is a source of some satisfaction for if the article is amusing it may set other people to thinking as well as "Perseveri," and if it does, then it has served its purpose. Just at this season of the year when so many young men are deciding whether to go to college or into a shop or to a technical school, it is especially desirable that a clear and straightforward understanding should be had of what a technical school can really do for its students. Therefore, I will try to answer some of "Perseveri's" questions.

Since he evidently, at least attended a technical school, he will realize that a man who is merely an instructor is not in a position to influence the policy of a school. However, if an instructor is sufficiently obscure he may oftentimes carry out some of his pet ideas without hindrance, because they are not known to the men further up.

Now for his question! Why do not I make a "bigger, better" impression on my boys than my anecdote implied? In the first place I do. The anecdote was given not to illustrate a blunder, but to show how students look on the question of thoroughness; and then again the only safe way to use approximate methods is to know the best ways, and to know thoroughly in what ways the approximate methods differ, so that successive errors may not keep "piling up," instead of offsetting one another.

To do this with students means the solving of a large number of problems of both kinds; requiring time, and it also means experience. In the present case I believe that I told the young man who thought that he could not afford to use any but approximate methods at "present prices," that I doubted if prices would rise for him until he got his approximations closer than 75 per cent. The trouble is that there is usually no attempt to make a problem look real, and unless a problem looks real and appeals to the student as a problem which might occur in actual life, then he will treat it as a school boy's job and not as a man's job. Just so long as teachers will go into the classroom with problems which are to them cut and dried, so long will the students act like boys. For my own part I seldom propose a problem to the class that I have done be-

forehand. I do not wish to even know if it can be solved. If my problem smacks of the practical, and the students see that I have to work it out myself while they are doing it, then it becomes a live topic, and they work with me and I with them. But how can a man do this with confidence unless he has run up against many such problems in the commercial world?

"Why dare not the average professor allow his students to realize that there is a region of doubt and disagreement beyond our fixed knowledge?" Possibly some do, but they are men who have back of them something more than book learning, or else they strive to create the impression that this region of doubt is so far beyond the region in which their students are floundering, that it may not be of interest to them. To my mind this is the most important part of a subject, not for student study, perhaps, but for discussion with their instructor so that they may know what ideas are most prominent, and the arguments advanced for each. Knowledge of this sort will do much to ease off that greenness which most young graduates show. Of course, if a professor is not acquainted with this region of doubt he will not dare to venture into it. A few can travel there safely; all ought to. Our college professors are ordinary men rigged out with high-sounding talk and long words to make an impression on boys. It is only human nature to have their desks on platforms and hold themselves on pedestals.

When "Perseveri" says that "the man who has conscientiously nibbled all around the roots will, at least, have chewed off sufficient of the tree of knowledge to form a sound basis for the structure which can be built only of material got first hand in the shops," I agree with him, but I do think that there is a great difference in the foundation laid in different schools, both as to depth and quality. I judge that "Perseveri" had his left off some little distance below grade. Other men find theirs up above grade and having a finish that, with a little pointing up and time to set, is fit to carry a good superstructure.

A boy who goes to a technical school has a right to expect that he will have a foundation clear down to solid rock, on which he can, later in life, build any sort of a superstructure which he has the ability to erect, and find it proof even against earthquakes. More than that, he has a right to expect to have his foundation carried enough above grade, so that, while it is seasoning, the vines and brambles will not grow over it and wholly hide it.

In other words, his right is to expect a training in the underlying, fundamental truths of life and of engineering, and in enough of the general principles of his chosen profession to give him a reasonable chance of success. Let this young man, however, beware of any school that promises him these things without work, and without work all the way through. Work is the one salvation of students and engineers alike. Beware of lecture courses unless accompanied by work in the laboratory or over the drawing board or in the shop! No man knows how to do a thing till he has done it. A correspondence course may teach you how to run an automobile and yet you may try to make your machine climb a telegraph pole the first time you meet a horse.

Pick out a school where the shop and the laboratory and the drawing room are used, where real work is done, and where commercial conditions are approximated. You cannot get into an atmosphere of work too soon. If anyone tells you that there are a thousand different jobs waiting for you, and that your chosen school only offers forty different studies, and that it is 25 to 1 that none of your studies will fit the jobs, tell him he is talking through his hat. The root of all engineering is in the same place. Tell him that you intend getting all the root that you can and to watch you grow.

Since writing my previous article I have attended the first reunion of my class since I was graduated from a technical school. Fifteen of us met after 14 years of actual life. One claimed to have had no good from his training. He was voted down and out. The unanimous opinion of the rest was that he and they owed whatever measure of success they had attained to the work and the foundation which they had laid in school. Of my classmates only two have consistently followed a single line of work. One, a chemist, is mechanical engineer for a vast plant. One, a mechanical engineer, is now a surveyor and highway commissioner. One, a shop superintendent for ten years, is now a teacher. Several have changed from mechanical to electrical fields, and *vice versa*.

They all voted, however, that the habits of work and of thought gained "on the hill" had been their making. All got on their feet where they could breathe freely in about two years after graduation, that is, they arrived where they did not feel on pay day that they were objects of charity. But nearly all agreed that it took them ten years to get where they could feel they had won a real foothold in the world. If this is the usual case, and I believe that it is, then there is no reason why a technical school should go beyond fundamental principles.

All of my classmates agreed that they owed the school for their ability to think for themselves, logically and independently along engineering lines. All agreed that they remembered but few facts that they were taught.

I do not know what there is to be cured in these methods. No man has a right to prosperity till he has learned the value of time and money through adversity. A boy graduated from school ready to take a $3000 job, and hold it, would make a poor citizen. The boy who has to make both ends meet on a dollar and a half a day for a while, can spend his money wisely when he gets more.

INSTRUCTOR.

Milling Cutters with Teeth Cast In

I note with interest the description of milling cutters with teeth cast in at page 824, but I do not feel that it is always economy to use cast-iron bodies as they will not stand severe work as will machine steel.

I spent a lot of time trying to make milling cutters in that way, but it did not prove reliable in my case and it was very expensive and the teeth would come loose when the cutters were put at hard work.

Foundries are not the best places to handle tools of precision and after spending hundreds of dollars in this line myself I feel like going slow in the matter.

Make the smaller cutter bodies of machinery steel, mill your slot standard and you can always duplicate the blades at any time. These are times when tools are worked very hard and the best is none too good. L. O. MASSOTH.

Estimating by the Toolmaker

The article, "Estimating by the Toolmaker," at page 253, put me in mind of some of my experiences in estimating on special tools.

To make a correct estimate is not easy, and it takes a good deal of experience. There is a great difference between an estimate and a guess.

However, there is to my knowledge not much difficulty in fixing the price of tools which are made for shop use only. The cost of such tools is a secondary matter, as the profit is to come from their product. An estimate is of more importance where the tools are sold, and where the competition of others in the same line of business has to be met.

In answer to an advertisement of ours a diemaker applied for work; in asking him the usual questions, he told me that he had been in business for himself, but had given it up. He was put to work and proved to be a good mechanic.

He had finished a die and, when I was inspecting it, he asked: "Do you mind telling me how much this die is worth?" To which I answered: "How much do you think?" He pondered a little and then he said: "Is it ten dollars?" I could not help laughing. His time on the job amounted to $13.55; material and blacksmith, $4.80; total $18.35, not including shop expenses or profit. I could not help telling him that he had probably done better for his customers than for himself.

This shows that a man may be a good mechanic and still not be able to know the value of his work, which is the first requirement for estimating.

Quite a number of men don't think it worth while to figure up how much time they put on a job. They don't seem to think that some day they might be asked to estimate. I believe that every man should have a note-book in which to keep the time spent on each job, and in doing so he will be able to judge intelligently the value of the work he has done.

When making my first estimate, I figured how many hours it would take me to do the job myself. Being only a few days in the shop, I had had no chance to find out what my help could do. But I was determined to find this out, so I decided to make my quotations in duplicate for some time to come.

To compare the result obtained with my quotation, I entered every order on another memorandum, noting the price quoted, the time for doing the work, and the name of the man or men doing it, also their rate of wages; thus:

Order No. 80643.	Article.	Price.	To Whom it Was Sold.
Name of Workmen.	Hours.		
C. B.	10-10-10-10	= 40 at 30 cents.....	$12.00
P. D.	3- 6-10- 6	= 25 at 27 cents.....	4.75
T. G.	5-10-10- 3	= 28 at 20 cents.....	5.60
M. L.	6-10- 4- 3	= 23 at 20 cents.....	4.60
			$26.95
Blacksmith.....			4.00
Material.....			8.25
Total.....			$39.10

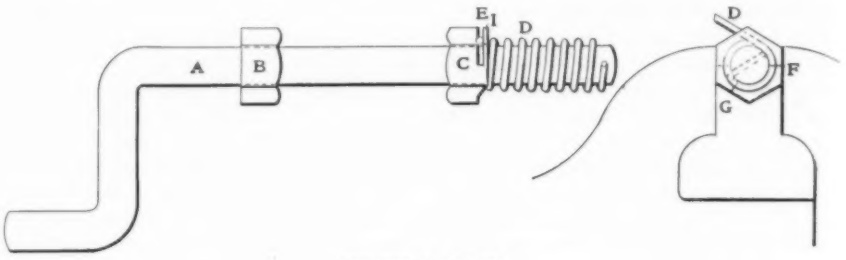
This may seem to be a laborious job, but it is easy. It takes only a few minutes every morning and it is well worth doing. After the job is finished I can tell in a minute the result. I can tell by it if my judgment in the ability of my men is correct. The results have been in most cases satisfactory, excepting where things happened which were beyond control. I have continued the use of the memorandum books, and they have accumulated to 14 in number. They contain a lot of information as to prices, methods of doing certain work, and mistakes. Yes, I have recorded my mistakes, too.

In the course of years I have gained a lot of experience in estimating and otherwise, but (I will not say that I am entirely fool-proof) of this fact I am reminded when I look at my memorandums, from every page I can see that time and patience are required to get experience, and that this experience cannot be bought at so much per pound.

L. Marteaux.

Making Compression Springs

Some time ago I had occasion in the course of experimental work to use a helical spring of size and pitch not in stock, and which very likely would be discarded for another and possibly still another during the course of the experiments. It was necessary that the pitch be uniform. As the lathes were all busy with other work and I wanted the spring without delay, I decided to make one. I tried to coil one by hand and saw I was up against it, so devised the inexpensive rig here shown.



COILING A SPRING

The mandrel is 5/16 inch diameter, so I used two ⅜-inch hexagonal nuts. In one of these nuts I cut the slot *E* a little over half the diameter of the hole in the nut *C;* then I cut away the portion *F G* parallel with the slot *E* and beveled it as shown. I then held the whole in the vise and, inserting the wire into the hole drilled into the end of the mandrel, proceeded to coil the spring, which came out equal to any done on the lathe. The pitch of the spring is governed by the thickness of the wall at *I*. The whole contrivance was made in the time it would have taken to change a lathe for the job, and has proved itself a serviceable device.

Dan Freuler.

Tempering Cold Chisels

Take them and first heat them gradually until they throw out sparks when taken from the fire, then let cool off slowly until a very dull red heat, then immerse in the following bath: 1 quart of heavy black oil; 2 spoonfuls of bromide of potassium. Do not put bath in tin; earthen ware is better. After removing from this bath place in fire, heat slowly to a low heat and hammer until all traces of red heat have left; then reheat to a very low red and place in a bath of strong brine just long enough to chill about 1 inch of the point, scour with emery and draw to a pale blue, after which cool off in the following bath: 2 quarts of lard oil; 4 ounces of cyanide of potassium; 2 ounces of salt.

The lathe and planer tools should be treated in exactly the same way only do not draw temper so low, just light straw color. I have had a great deal of experience in this way of making tools for the past four years and find them far superior to any other method I ever saw or heard of.

H. F. Clifford.

The Hindley Spiral Gear

Your editorial about the Hindley spiral gear is likely to convey the idea that such a gear is better than gears cut on true cylinders. But why better? Are they stronger? Will they run easier or wear longer? Who knows how much more an ordinary length of tooth will stand if pressure is applied the whole length of the tooth than if applied at a single point in the middle of its length and at the pitch line? Likely there is a difference, but how much? I have seen too many gear teeth with the corner broken off, yet doing the same work as before, to believe that there is much difference.

And as to the wear, it seems to me that the experience gained by the Sellers planing machine demonstrates that a single-line contact will outwear the screw and nut doing the same service; and the screw and nut is the limit of worm-gear contact. If the single-line contact outwears the other, is it not pretty conclusive evidence that it runs easier? When some of our testing laboratories make the test, if fairly done, we shall know.

For 25 years we have been running a cylinder-boring machine in which we have bored hundreds of cylinders. The bar is driven by a cast-iron worm ¾-inch pitch, double thread, and an 18-inch plain spur gear, except that the teeth are cut at the proper angle. The worm itself is worn but very little, and the gear has hardly more than polished places at the points of contact.

I know very well that the readers of the American Machinist are not going to believe me, or, at least, they are not going to quit hobbing gears nor believe it is not the right thing to do; except perhaps now and then one may be hard up for a worm gear, pick up a spur gear and use it until he gets time to put in a

hobbed one, and find that the time to put in the hobbed one never comes.

I have a theory (or notion, perhaps it would be better to call it) which is that the reason the spur gears do not wear out is because the two points of contact of both parts are instantaneously and constantly changing.

The theory based on the experience in other things argues that the hobbed gear is about right, and that the Hindley gear is better; experience indicates to me that a worm in a spur gear is better yet.

JOHN E. SWEET.

A Milling Jig

This jig is simple and yet effective for milling the casting shown, in a gang of four. The castings are milled on both

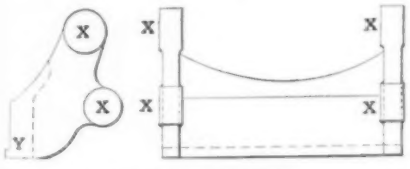


FIG. 1. THE CASTING

sides of the bosses $x\,x$ at one setting. At first it looked as if it would be difficult to design a jig that could be operated quickly and still hold the castings firmly while being milled. On looking the casting over it was found that the guiding edge Y would be a great aid.

A is the body of the jig. $B\,B\,B\,B$ are the guiding slots for the edge Y. These slots are planed straight with the tongue

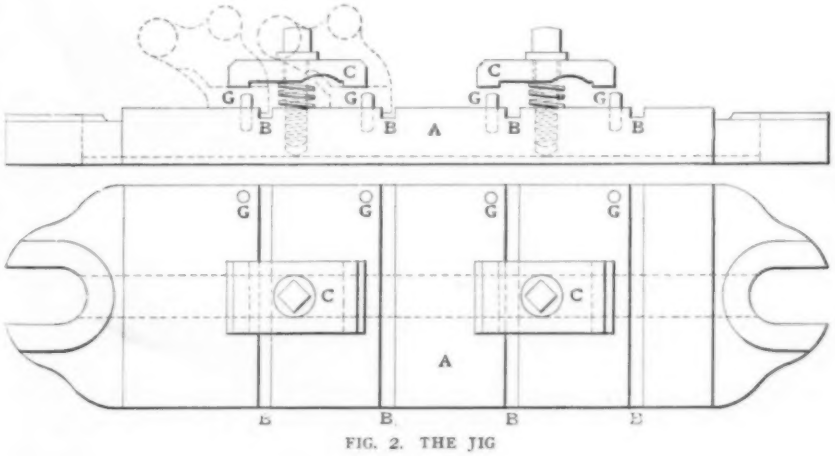


FIG. 2. THE JIG

of the jig. $C\,C$ are clamps which hold down two castings at a setting.

To operate the jig, a casting is placed in each slot and is brought against the stop G. As the clamps are held up from the jig by springs, there is no trouble in slipping the castings under.

The side view of the jig shows in dotted lines two castings held in position ready for milling. PEDRO.

A Taper Gage

Mr. Casey's diagram for setting the tailstock, page 534, reminds me of a gage that I made some time ago, and still have in my tool box. At the time I made it I was working in a tool room where we made a good many end mills with Brown & Sharpe taper shanks, but had no taper attachment. I have since found it quite

A TAPER GAGE

convenient in setting taper attachments also.

I submit a sketch herewith. In use the piece to be turned taper is first turned straight and the end faced, then the gage is placed with the V on the straight part of the work and the strip, which is fastened to the small end with a screw, bearing against the faced end of the work. Then the tailstock is set over until both ends of the gage strike alike against a tool held in the tool post, with its point the same hight as the lathe centers, using the gage much like a caliper and rocking it back and forth between the work and the tool. It will be readily seen that the length of the work has nothing to do with it in this case.

I made this gage just three inches long, hardened it, and ground it on centers, the taper corresponding to Brown & Sharpe's standard. I use it for other tapers, together with a thickness gage, something after the following manner: The taper in three inches B. & S. or ½ inch per foot equals $\frac{0.5}{2}$: 12 as x: 3 or 0.0625; and in Morse No. 2 and 3 or 0.602 inch per foot equals $\frac{0.602}{2}$: 12 as x: 3 or 0.075; 0.075 — 0.0625 equals 0.0125. Hence a thickness gage 0.0125 thick held on the large end of the gage between the tool and the gage will give approximately a Morse No. 2 or 3 taper. Other tapers may be figured in the same way. TAP.

Formula for Outside Diameter of Curved-face Worm Gears

The following formula for finding the outside diameter of curved-face worm gears may be useful to some of your readers. The accompanying cut shows the dimensions used and is self-explanatory.

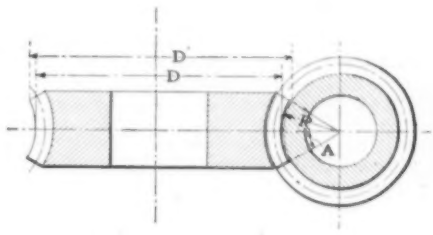
Let D = Diameter of gear at throat.

D' = Outside diameter of gear.

R = Distance from center of worm to top of worm-gear teeth.

A = One-half included angle between edges of worm-gear teeth.

Then $D' = D + 2$ (versine A) R



CURVED-FACE WORM GEAR DIMENSIONS

I frequently make the width of the gear equal to one-half the diameter of the worm. Then A becomes 30 degrees and $D' = D + 0.268R$. B.

Y

Practical and Cultural Training in Technical Schools

In an editorial on our Coöperative Course in Engineering at page 860, you spoke a word of caution against a lowering of the standard of broad culture in the work which we are doing.

It gives me a great deal of pleasure to assure you that the students in our cooperative course receive just as much academic work as the students in our regular four-year courses. In fact, the period of time given to this work, namely, six years, enables us to broaden the courses, to a certain extent, along cultural lines. The entrance requirements are just as high for this course as for the regular course.

HERMAN SCHNEIDER,
Dean, College of Engineering, U. of C.

Damages to the extent of $101,000 were recently awarded against the New York Central & Hudson River Railroad Company for the death of a man who was killed in an accident at Van Courtlandt Park, in June, 1904. This accident appears to have been particularly flagrant as it occurred at a railroad crossing where the warning bell was out of order, and where the approach of the train was obscured by another train standing at the station.

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Noteworthy Engineering

It is not unusual to see a record of some new feature of electrical engineering, opening new possibilities for the application of electrical energy in our industrial life. Indeed such strides have been made that the often used expression "Electricity is in its infancy," should be forever banished. It has now rather reached the full stature of vigorous manhood.

A paper presented to the Iron and Steel Institute by E. Selby Bigge, entitled, "Development of Electricity in the Iron and Steel Industry," treats of the application of electrical motors, to rolling-mill service in an Austrian plant at Trzynietz. The results which were obtained are sufficient to warrant the use of the expression, *noteworthy engineering*.

The installation consists of a reversing mill of one train of rolls with four sets of housings. The roll centers were normally 2 feet 6 inches apart. The duty of the mill is to roll ingots of a maximum weight of two tons and approximate dimensions of 16½x18 inches by 5 feet 6 inches in length; cogging these ingots to billets for rails and girders and further rolling the billets into rails and girders. The mill thus combines cogging, roughing and finishing in one operation, and the time allowed for the complete rolling of the largest girder section from the ingot is from 5½ to 6 minutes.

Originally the mill was driven by direct-connected steam engines of the twin-cylinder horizontal type, having cylinders 48 inches in diameter by 50 inches stroke, taking steam at about 90 pounds pressure and running at a maximum speed of about 100 revolutions per minute. The engine was replaced by three motors coupled direct to the mill shaft, each of the following capacity: 330 volts, 120 revolutions per minute normal, 1200 normal to 3000 maximum brake horse-power, to which adding the extra overloading capacity brings the total combined capacity to about 10,350 brake horse-power.

In the system is a fly-wheel balancing installation consisting of one three-phase motor coupled between two continuous-current generators and having two heavy fly-wheels. Quoting from the paper referred to: "This balancer is on the Ilgner system, and is the crux of the whole situation, forming the medium whereby the excessive peaks caused by rolling and reversing are reduced to a mean, straight and comparative low-load line demand from the power station."

The rating of this induction motor is 390 amperes at 3000 volts, 50 cycles, and a speed of 310 to 370 revolutions per minute. The fly-wheels are 13 feet in diameter, weigh 26 tons each and have water-cooled brakes adjusted to their peripheries for stopping the set quickly when occasion demands.

The boldness of the conception of this installation is shown by the following paragraph, which is quoted from the paper referred to: "It must be understood that, no reversing mill of any magnitude having been driven electrically previous to the conception of this one, there were absolutely no comparative data upon which to base the necessary calculations."

Many problems had to be considered in its design. Distribution of horse-power, the inertia of magnetism, the effect of current fluctuation on voltage and generating units, speed regulation of the motors and the impracticability of an enormous reserve generating plant, were some of these questions. The conditions were, however, anticipated, provided for in the design and successfully met in operation.

A few points of its operation are: time for accelerating the rolls from rest to full speed, 4 seconds; momentary current as much as 10,000 horse-power but current taken from the mains at the same moment only one-tenth that amount or 1000 horse-power; time of accelerating balancers from rest to full speed, not over 8 minutes. Some features of the electrical operation are thus described by the author:

"It is interesting to see how the current passing from the Ilgner dynamos to the mill motors, the voltage of the Ilgner dynamos and the speed of the mill motors rise and fall together, for the current taken by the Ilgner motor and the kilowatts reflected on the generating plant remain almost constant, except when the pauses between the actual rolling are longer, at which time the current on the Ilgner motor, and the watts reflected gradually fall off . . . . such an electrically driven mill constitutes an excellent load to have connected to any power station, especially as the rotating masses of the fly-wheel act to a large extent as a balancer for the whole system."

The control of such an installation is, of course, one of the most important features, and in the author's own words, "As a matter of fact, the most remarkable part of the installation is the simplicity of control and the small dimensions of the controlling apparatus. One man, with a simple controller having a single lever, performs the operations of running, reversing and controlling the mill. The apparatus is contained in a case having dimensions not exceeding 3 feet 6 inches long by 3 feet wide by 3 feet 6 inches high. The whole operation is carried out by a simple to and fro movement of a single lever. The maximum controlling current would certainly not exceed 150 amperes, and one can readily understand that this can be far more easily dealt with than such currents as 8000 to 10,000 amperes, which would be required if the main current had to be controlled.

"The whole of the rolling-mill and central-station equipment just described represents one of the most carefully thought

out and practical schemes it has ever been my privilege to inspect. With nothing before them in the way of precedent to guide them, the designers have successfully accomplished a feat of which they may justly be proud, and the author must also congratulate them upon the successful outcome of their work. The first reversing rolling mill, just described, has been in operation only about nine months, and already two reversing mills of 10,000 horse-power each have been started in Hungary; one of 15,000 horse-power is being erected in Metz; another is to be installed at Husten. It will therefore be apparent from the rapidity with which the matter has been taken up on the continent what very great importance is attached to the subject. Indeed in the author's opinion the day of the electrically driven rolling mill has come and has come to stay."

Great credit is undoubtedly due to the European engineers who have carried through this piece of engineering work. The advantages of such an installation are apparently many, and if the necessary element of durability is present its success is real. We shall all look forward with interest to the work of American engineers in the same field.

Practice and Theory Not Practice versus Theory

How many times we have heard from practical men an expression something like this, "Theoretically that may be so, but practically it is———." The expression and the thought behind the expression imply antagonism between theory and practice. This idea of an unbridgeable gap, of a difference of goal, between the ultimate result of the man who works out true theories and the man who works out consistent practice is very common. But is it true?

A companion editorial discusses a notable work of engineering—the design, erection and operation in Germany of an electric drive for a large reversing rolling mill. The engineers had no precedents to follow and had most rigorous and exacting conditions to meet. With great care these conditions were analyzed and determinations made for such quantities as time, acceleration, inertia of mass, inertia of magnetism, stored energy, power, and others. These were problems in mathematics, questions of computation, analysis from theory.

The electrical equipment, involving the supplying of 10,000 horse-power at times for the rolling mill, of reversing and of accelerating from a position of rest to one of full speed in four seconds, was designed, erected and started. With what practical results? Reversals and accelerations are accomplished in the time estimated, and the demands for current from the generating station vary within only narrow limits from a constant average, although the power used in the mill motors may be ten times as great. The plant has been operating for about nine months with satisfaction, as shown by the fact that four other similar or larger installations are in progress for the same work. Thus theory and practice reached the same end. The engineer designed the plant to accomplish certain results. The practical man made the machinery for the designs and a practical man accomplished with the machinery the results which were outlined in the conceptions of the engineer. It is always thus. True theory and consistent practice agree. The apparent antagonism has been fostered by imperfect or erroneous theories, and by incomplete and poor workmanship.

Let us, however, appreciate the precise agreements of these two elements in our industrial life, when properly worked out, and instead of saying *theory versus practice*, let us say *theory and practice*.

Patents and Trademarks in Japan

The statistics from the Japanese Patent Office, as translated by our correspondent, A. Gaikoknjn, disprove conclusively the oft-repeated statement that the Japanese are only imitators, and not originators of ideas. It also brings out the fact that Germany evidently places great dependence on trade marks as a means of securing and holding trade, and is striving to become the ruling power by this method. The translation follows:

By the latest investigation by the Patent Bureau it was found that the number of inventions registered from the time when the patent law first came into existence (in 1884) to April 8, this year, stands as follows: Patents, 11,953; innovations for practical use, 5119; designs, 3910; trade marks, 29,140. In the last year there have been 1107 patents, 3155 innovations for practical use and 614 designs registered. In trade marks and designs Osaka stands first, Tokyo and Hyoyo coming next. As to patents, Tokyo heads the list, Osaka second and Kyoto third.

The number of foreign inventions registered in the past year is found to be as follows: America, 720; Great Britain, 380; Germany and France coming next in order. In designs Great Britain has 10; America, 2; Germany, 2; and in trade marks Germany stands first with 1580, while Great Britain, America and France come next in succession with 1560, 400 and 300, respectively.

New Publications

FORMELN UND TABELLEN DER WAERMETECHNIK, ZUM GEBRAUCH BEI VERSUCHEN IN DAMPF-, GAS UND HUETTENBETRIEBEN, by Paul Fuchs, Engineer. Buckram, 43 pp., 5¼x8¼ inches; Julius Springer, Berlin. Price, 2 marks.

This is a collection of tables and explanatory matter regarding the properties, heating values and mixture proportions of fuels, which should be of assistance to the engineer, chemist, and physicist who uses the metric system in his work.

DIE HERSTELLUNG DER DAMPFKESSEL. By M. Gerbel. 82 pp. 5¼x8¼ inches, with 60 illustrations. Julius Springer, Berlin. Price, 2 marks.

The author confines himself to setting forth the elements of the art of making boilers, including a description of the materials used; starting with laying-out he explains the various processes of getting the plates into shape for assembling, riveting, calking, etc., and the machines and tools used in the operations. It is almost wholly taken up with work-shop processes, being free from mathematics, and not considering the subjects of selection of types of boilers, design, boiler performance, etc., though in the chapter regarding the examination of materials there are reproduced several micro-photographs of irons and steels which have been polished and etched, and there is a table giving the results of tests of steel plates. This little work will probably be of interest and instruction to many who want to know of what and how boilers are made.

PRECISION GRINDING. By H. Darbyshire 162-6x9 pages; 39 illustrations, 3 tables. Hill Publishing Company, New York. Price $2.

The author of this book, who is a well known contributor to the columns of the AMERICAN MACHINIST on grinding and kindred subjects, sets forth in this volume some valuable information which should be of service to users of grinding machines in general. He deals briefly and to the point with the advantages of grinding, describes various classes of grinding wheels and methods of making and grading them, discusses speeds and feeds of wheel and work and the effect on output and quality of finish, of coarse and fine grits, hard and soft wheels, broad and fine side feeds, etc. One chaper is devoted to plain cylindrical grinding and another to plane surface grinding in which the use of the magnetic chuck is taken up along with other matters pertaining to this line of operations. Some causes of defective work such as temperature, improper methods of chucking, poorly fitted arbors, etc., are treated in a way that should make this section of the book especially useful to grinding-machine operators. The last two chapters of the book are devoted to laps and lapping, and measuring tools and gages, both of which subjects are of importance in connection with the finishing of precision work.

Glasgow's export business to the Philippines shows a large increase for the year 1906. The total exports of iron and steel ran to $181,493 against $10,688 in 1905, while the machinery line shows an increase of $13,639 over 1905.

New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

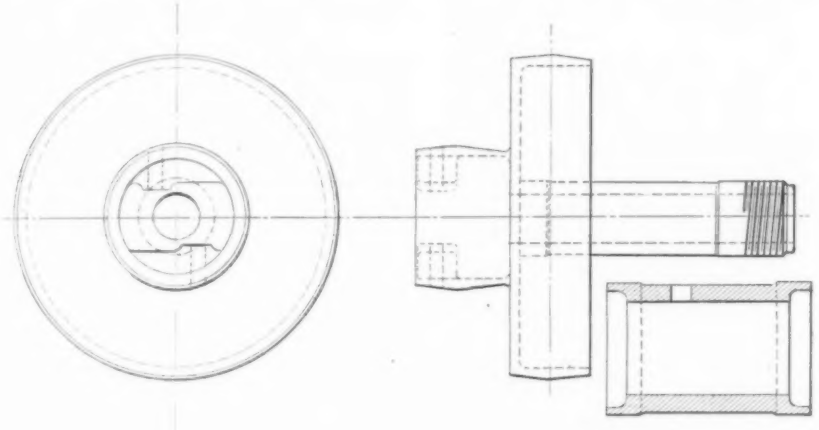
New Model Drill Press

One of the improvements in the present design is an entirely new spindle pulley construction whereby the hub is made extra long and the ball cases made in one piece, as shown in the details. This insures perfect alinement and confines the wear entirely to the ball cases and cones. When the new spindle pulley is assembled with drive blocks, ball cases, cones and balls, it may be handled as a complete member and may be placed in position in the pillar or removed at will by adjusting two screws in the pillar head provided for the purpose.

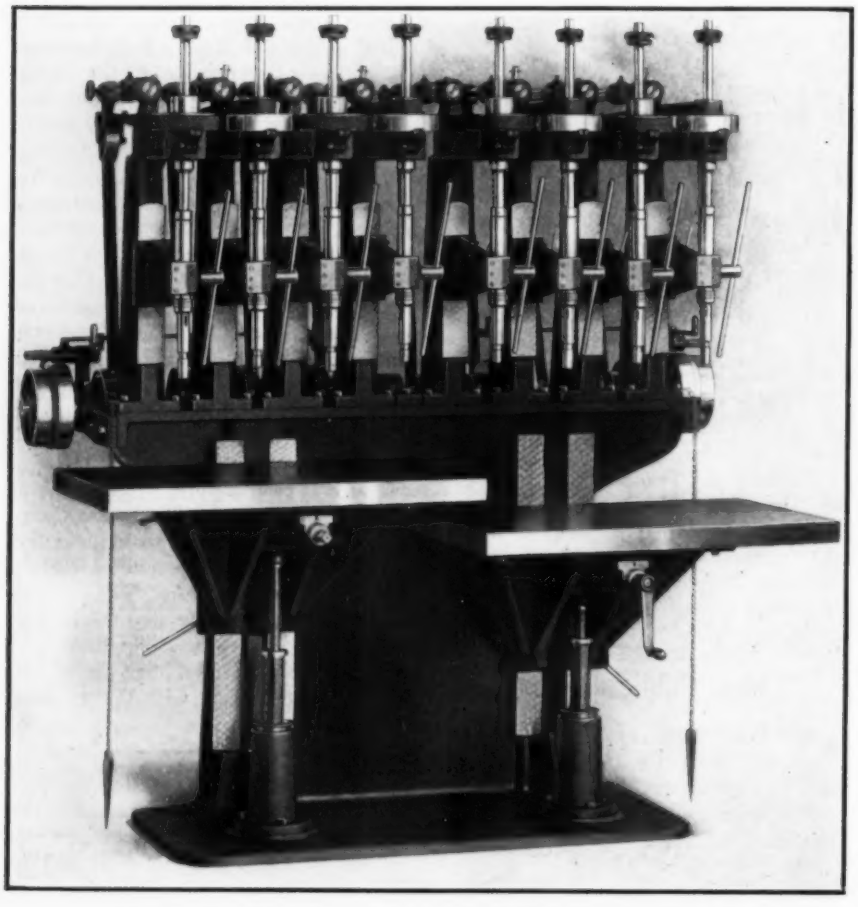
The new spindle drive is by means of two square blocks set at the proper angles in the top of the spindle pulley as indicated in the end view. These blocks may be readily replaced but as they are hardened steel this is not likely to be necessary very often. This gives a very quiet drive for the spindle.

The pillars have been enlarged and are tapered from the top to the base to allow of the use of a heavier weight to give quick return. The new shipper brings the handle to the nearest practical point for the operator and is furnished on both sides of the machine on multiple spindle drills.

The idler used to raise or lower the belt to the step on the spindle pulley desired is furnished with a bayonet catch instead of the hand screw formerly used; this method makes it impossible to adjust the belt half way. The weight of the



DETAILS OF PULLEY CONSTRUCTION USED IN THE DRILL PRESS



EIGHT-SPINDLE DRILL WITH TWO TABLES

castings throughout the machine has been increased to give greater rigidity and all spindles are furnished with 1⅛-inch nose to give greater strength to the spindle when large drills are used.

The new model is made in from one to eight spindles and with 7-, 9½-, 12- and 15-inch overhang so as to drill to the center of a 14-, 19-, 24- and 30-inch circle.

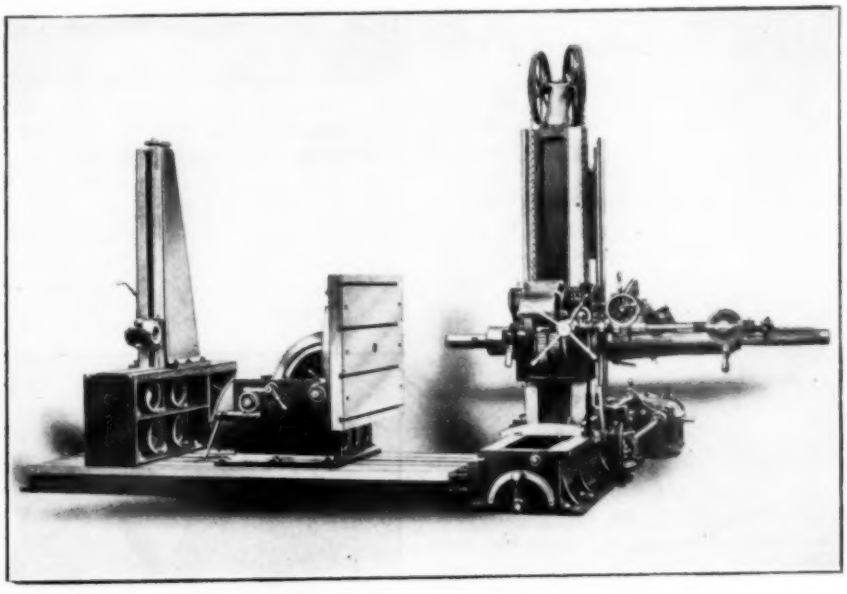
In the 8-spindle machine shown, the base is made in box form to give the great rigidity required in a machine of this character. The tables of this machine are also provided with two heavy telescopic raising and lowering screws and there are two tables instead of one as in the other sizes. The two tables and raising screws allow an operator to work with oblong jigs when required, as one of the tables may be raised to the proper hight to support the long side of the jig while the other is adjusted to the proper hight for the short side. This machine is also provided with a separate tight and loose pulley for each of the four spindles so that the eight speeds may be adjusted for either tapping or drilling.

A small two-piece pulley is provided for these machines when desired, which may be clamped to the rear shaft, fitting under the small face of the driving pulleys and small enough to reduce the speed at the drill point sufficiently for tapping.

These are made by the Henry & Wright Manufacturing Company, Hartford, Conn.

A Large Horizontal Boring Machine

The accompanying engraving illustrates a new machine, designated by its builders, the Fosdick Machine Tool Company, of Cincinnati, O., as their (Style D) No. 2 horizontal boring, drilling and milling machine. It has a constant-speed drive, which can either be driven by a single belt or geared direct to a constant-speed motor, or a five-step cone pulley can be substituted for this constant-speed drive.



A LARGE HORIZONTAL BORING MACHINE

The machine has a 42x127-inch bed plate tongued and bolted to the main bed. The wide upper surface of this bed carries the column with its saddle, which is gibbed down to a sliding fit on a wide scraped bearing. The longitudinal travel of the column on this bed is 62 inches, the spindle head being mounted on this column. The vertical travel of the spindle head is 54 inches. The spindle head is fully counterbalanced and can be adjusted by the pilot wheel, or can be raised and lowered, or fed by power, eight feeds in all directions being provided for this. The eight feeds referred to can be used as follows: To feed the column horizontally on the bed, the spindle head vertically on the column and the spindle horizontally. All these movements can be instantly reversed. The pilot wheel shown can be used to run the column forward and back, raise or lower the spindle head or run the spindle forward and back rapidly. For heavy milling the column can be fed backward or forward on the bed. This throws the strain of the cut upon a screw of suitable diameter and lead with its ball-thrust bearings. This feed can be controlled by the lever shown on semi-circular guide on the front of the machine.

The drive consists of a speed box with positive gear changes, which are easily and noiselessly changed to their different speeds. This drive has six changes of speed, and with two changes on the head allows of twelve changes of spindle speed from 4 to 260 revolutions per minute.

A friction device of the toggle-joint type is placed between the back gear and the speed-changing device, which can be used for starting, stopping or reversing the entire machine.

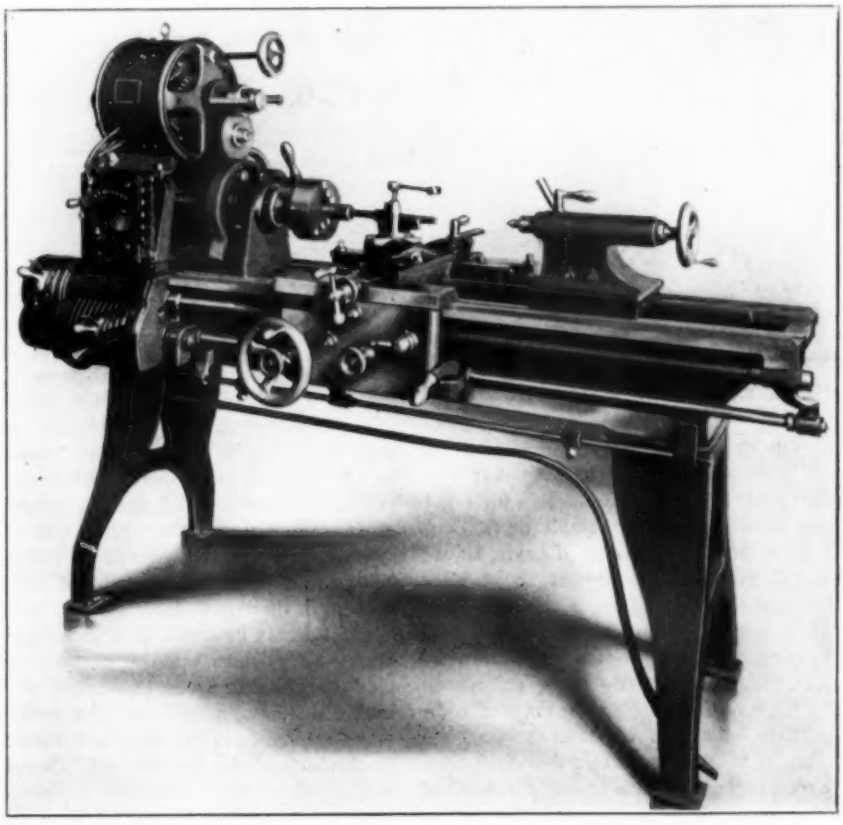
The spindle-sleeve bearings are of very large diameter and length, and fit into adjustable taper bronze bushings, which allow of easy adjustment for wear. The spindle sleeve is fitted with a threaded collar of large diameter, which carries a device used to tighten securely the spindle bar centrally in any position desired. The spindle bar is 4 inches in diameter, has 30-inch travel by hand or power, and is fitted with a No. 6 Morse taper.

The bed plate has a rack inserted in which the pinions, operated by ratchet wrench on the outboard bearings and universal table, mesh to operate these respective parts to and from the spindle. The outboard bearing's horizontal movement is operated by a rack and pinion, while the vertical movement is controlled by a crank and screw arrangement.

The universal table has a 40x46-inch platen. It has a hole bored through its center to allow of passing the boring bar to the outboard bearing. The tilting motion, as well as the swiveling motion, is imparted to the platen through a worm and gear in conjunction with a circular rack and pinion. The table is provided with tighteners to clamp all parts rigidly to any angle. The weight of the complete machine is 21,000 pounds.

Variable-speed Motor for Lathe

The lathe shown with the motor mounted over the headstock is a 14-inch Hendey with a 6-foot bed, which gives a good idea of the size of the one horse-



LATHE EQUIPPED WITH VARIABLE-SPEED MOTOR

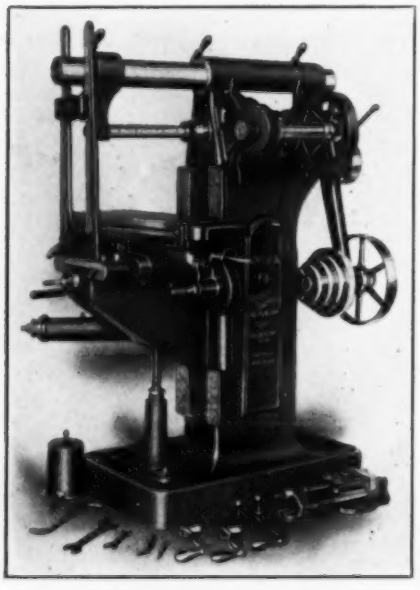
power variable-speed motor made by the Lincoln Motor Works Company, Cleveland, O.

This motor has a speed range of from 500 to 2500 revolutions per minute, controlled by the hand wheel which is in a convenient position for the operator. There is also a clutch, worked by the short horizontal lever shown over the gears, which allows starting and stopping the machine without stopping the motor.

The combination is very neatly arranged without the usual cumbersome speed controlling devices and the maintaining of the full power of the motor at the varying speeds is a very desirable feature.

Plain Horizontal Milling Machines

These machines are made in two styles, back-geared and not back-geared respectively, known as Nos. 25 and 26. In their design special attention has been paid to the requirements of the manufacturer of small machine parts which are produced in large quantities, such as are found in small arms, typewriters, sewing machines and electrical work. In bringing out the new model, special attention has been given to the feed works; this new feed is driven by belts which get their motion from the spindle of the machine by means of a train of gears, so arranged that the velocity of the belt is sufficient to drive all feeds that the main belt will stand. The changes of the feed are obtained by four-step cones and by interchanging the feed-driving pulleys on the back of the machine, giving in combination eight changes from 0.007 to 0.100. The longitudinal feed is 34 inches, the cross feed 8 inches, and the vertical adjustment 18 inches.



PLAIN BACK-GEARED MILLING MACHINE

The table is operated by worm and hobbed rack, the worm being driven by means of a worm gear of large size and worm of coarse pitch and of correspondingly high efficiency. The arrangement for disengaging the feed is by a new and novel drop-worm mechanism, by which the worm is thrown out of mesh with the gear, and leaves in a path at right angles with the axis of same, overcoming the objection of the old-style gravity drop-worm of clinging to the gear by friction alone. It also equalizes the wear on the worm-gear teeth. The worm is also engaged and thrown out of mesh by the same lever. The table is also supplied with a hand quick return of 4 to 1 ratio.

The knee of the new model has been lengthened sufficiently so that a harness brace may be used for the arbor and still have a cross range for the table equal to that of the old-style machines; this harness consists of a brace which is gibbed to the knee slide, a clamp that is fastened to the arbor support yoke in a manner that allows it to be swiveled around its centers, allowing the brace to be removed without removing any bolts. The arm, which is a solid steel bar, is adjustable lengthwise. These machines are equipped with a rigid box knee and with a telescopic elevating screw. The spindle cone and back gears are of the standard Becker-Brainard design, the spindle bearing being cylindrical in form, the wear being taken up by concentric compensating bronze boxes.

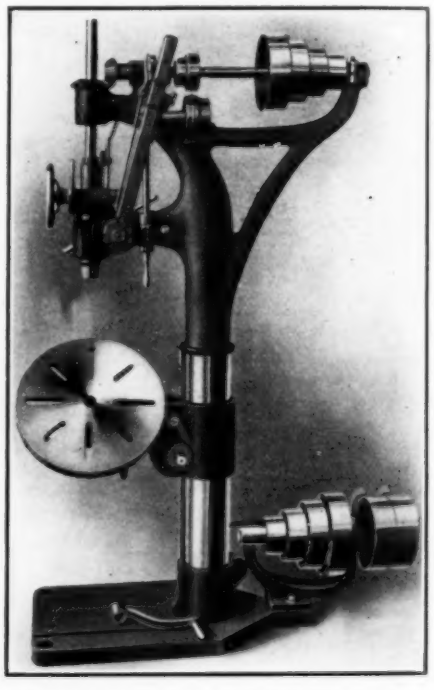
These machines, the net weight of which is 1650 pounds, are made by the Becker-Brainard Milling Machine Company, Hyde Park, Massachusetts.

A. C.-D. C. Recording Voltmeter

A recording voltmeter for use on either alternating-current or direct-current circuits has been brought out by the Bristol Company, Waterbury, Conn. It is made in both switchboard and portable forms and designated as Type 8. This instrument is constructed on the electric balance principle without the employment of permanent magnets, the essential parts consisting of two coils mounted side by side, one stationary, the other mounted upon steel knife edges. A pen which receives its motion from the movable coil makes a permanent record in ink upon a revolving chart. Operation upon either direct or alternating current is assured by the coils being wound non-inductively and having no iron in their composition. The switchboard form is mounted in a nickel-plated bronze case which may be obtained with binding posts for front connection or for back connection, as desired. An auxiliary series resistance is furnished for mounting on the back of the switchboard. The portable form of this voltmeter is mounted with its auxiliary resistance, in a light wooden carrying case provided with leveling screws. The metal back of the instrument, as well as the metal parts of the auxiliary resistance, are made of aluminum. The case complete with operating supplies, such as charts, ink and clock key, weighs 11 pounds. During transit the moving parts are held rigidly by a spring clamp. Binding posts are conveniently located inside the case, which is 5¾x12½x17 inches. The instrument uses an 8-inch chart, two hours or 24 hours per revolution, and may be obtained with various volt ranges.

Drill Press with Universal Table

One of the principal features of the drill press shown is the universal table which will commend it to shop having holes to drill at different angles. A table of this kind does away with the necessity of changing and re-clamping the work on the drill table, as with the table fixed in one plane. This table can be clamped at any angle desired between level and vertical positions.



DRILL PRESS WITH UNIVERSAL TABLE

The bearing for the knee carries the steel rack so that it can be raised and lowered in the usual manner, regardless of its position on the column.

The table is supported by a universal head on the outer end of the knee, fitted in a very rigid manner, and fastened in position with a split bearing and clamp screw to make it as rigid as possible.

This machine is furnished with universal table or solid knee, lever feed, wheel and lever and quick return, with wheel and lever, and power feed and automatic stop, also with back gear. The bevel gears are planed, and are covered for protection from accident; all gears are cut from the solid.

The spindle is of special carbon steel, well fitted and supported in the sleeve by nuts with fiber thrust collars. The hole is Morse Taper No. 3. By movement of a lever conveniently located to the operator, any change in combination can be had.

The column is heavy and secured to the base by clamping bolt; the base is provided with T slot and foot belt shift for starting and stopping. The machine is designed for hard service with every part interchangeable and accurate in construction and operation.

It is made by the Robertson Manufacturing Company, Buffalo, N. Y., and is known as their Universal No. 21 drill press.

Adjustable Reamer

The noticeable feature of this reamer is the fewness of its parts, there being but three pieces aside from the blades. These are the shell, the cam or adjusting bolt and the nut which draws the bolt, and with it the blades, against the shell, locking them solidly in place.

The cam bolt, shown at the left of Fig. 2 with a blade in place, has as many cam surfaces as there are blades to the reamer. The rise of these cams varies from 1/64 inch in the ¾-inch reamer to 1/16 in the 6 3/16-inch reamer, the largest on the regular list at present. The total adjustment is of course double this, as it adjusts both blades at the same time. The end of the sleeve is indexed so that the cam bolt can be turned accurately any desired amount, each division representing an increase of 0.001 inch in the diameter of the reamer. Adjusting keys are furnished in each case. The cam bolt has also an angular sleeve that locks every blade at once when the nut is tightened after the adjustment is made. When locked, the blades are held rigidly against the hardened cam surface by angular lugs engaging the cam-bolt sleeve and the blades are firmly seated in the end of the shell slots, so that they are well supported.

The cam-bolt adjustment does not move the blades endwise in the least, so that the front of the reamer is always free from obstructions which might interfere with reaming to the bottom of a hole.

All adjusting parts are protected from dust, grit and injury of any kind by being housed within the shell. This also leaves the outer surface of the reamer free of obstructions, so that the chips have free outlet and all clogging is avoided.

The cam-bolt system of locking and adjusting permits any size within its range to be obtained in a few seconds and makes it possible to sharpen the reamer and adjust it to the exact size afterward. By keeping the socket wrench in the toolroom it is impossible for any unauthorized person to tamper with the size of reamer. The manner of adjusting the blades gives a wide range of metal for regrinding, and when ground to their limit they become full-sized blades for the next smaller size reamer. This transfer of blades is made possible by having the slots uniform in all reamers having the same length blade.

The clearance of the cutting edge is radial, this being accomplished by a blade-grinding jig. These jigs are made in fourteen sizes and are furnished, if desired, so that this grinding can be maintained, or they may be ground in any other way desired. The radial grinding used has been selected after tests in various kinds of metal as being the best clearance possible for free cutting and avoiding chatter at the same time.

The reamers are made a floating fit on the arbor to allow perfect alinement and are driven by the key shown, which is of tempered steel. As the shell is of full diameter at the slotted end, this gives a very strong drive, suitable for the heaviest work.

This reamer is made by the Wm. J. Smith Company, New Haven, Conn.

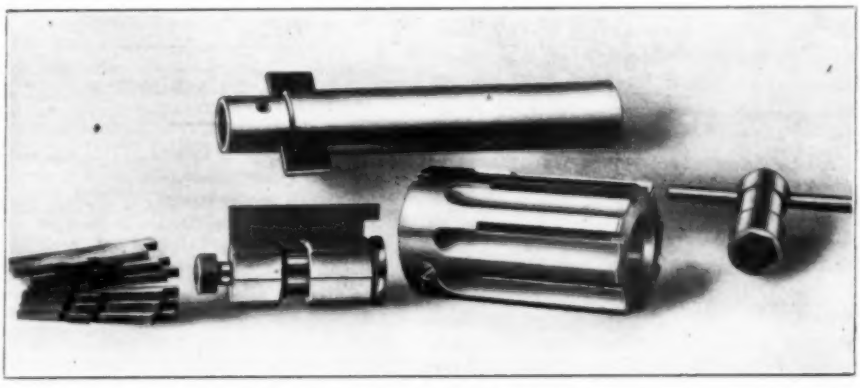


FIG. 2. THE REAMER IN PARTS

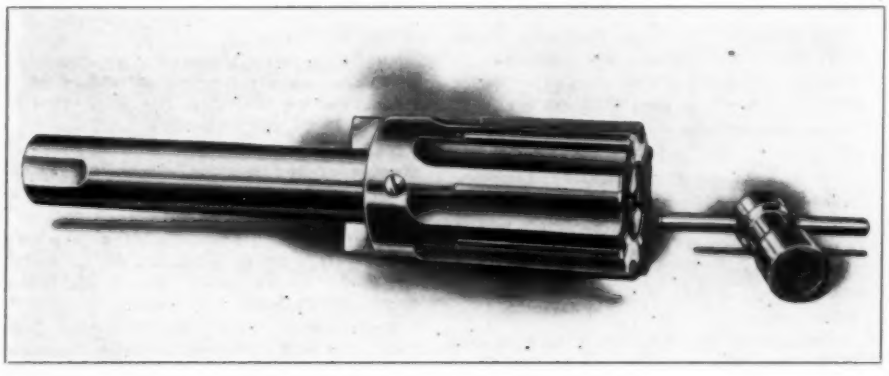


FIG. 1. REAMER ASSEMBLED READY FOR USE

An Important Steel-rail Discussion

Notwithstanding the claim of inspecting engineers of some of the leading trunk lines that the rapid increase in the number of rail breakages is due to inferior steel and insufficient rolling of the sections, no data were offered which would bear out this contention in a discussion of this subject at the annual meeting of the American Society for Testing Materials.

On the contrary, statements made by the railroad representatives indicate that the weight of rolling stock is excessive for even the heaviest section as at present designed, nor has the increase in the weight of the section been proportionate to that of the locomotives and cars in recent years. The statement was made that 85 per cent. has been added to the weight of engines and on the drivers since 1885, yet during that period the increase in the weight of the rail sections would barely average 30 per cent.

Considerable evidence was also offered which would indicate that many failures result from the operation of locomotives that are not properly counterbalanced, and flat spots on drivers likewise produce many fractures. Investigation of some 50 breakages on a Western road conducted by a non-interested party showed that all of the broken rails were taken from one side of the track, and it was found that the locomotives on this division, which had a slight grade, had a tendency to swerve toward this side. Steel tie plates, it was believed, also were a contributing factor, as many of the failures occurred immediately over them. Analyses to ascertain the chemical properties of eight of these rails showed them to be normal, and the elements were all well within the specified limits.

The numerous suggestions offered to

overcome this difficulty showed a wide difference of opinion, among not only the rail makers, but the railroad engineers as well. That a change in the design of the section might materially aid in the solution of the problem was generally admitted, but the railroad interests hesitate in the adoption of a section above the present limit in weight. It was pointed out that the design of the American rail section does not admit of sufficient manipulation of the steel due to the large mass of metal in the head, which carries the heat longer than the much thinner web and flanges, the head consequently not being rolled at a sufficiently low temperature. A section having the same width of head as the present 100-pound rail, designed by the American Society of Civil Engineers, having sufficient metal in the web and flange to carry enough heat to allow the head to be finished at a lower temperature would, according to one of the speakers, have a weight ranging from 120 to 125 pounds to the yard.

Driving-wheel weights have increased up to 30,000 pounds per wheel, and the crushing tendency of such loads is undoubtedly greater than the steel used in the manufacture of rails, and as specified by the railroad interests themselves, can withstand. One Eastern road is reported to have prepared new specifications which none of the railmakers is inclined to meet at the prevailing quotations. Until a satisfactory price is reached no contracts will be awarded for 1908 requirements, and the outcome is awaited with interest by the other railroad interests that are considering radical changes in their specifications.—*The Iron Trade Review.*

Remington Typewriter Bonus

The ninth semi-annual bonus distribution at the Remington Standard Typewriter factory, Ilion, N. Y., owned by Wyckoff, Seamans & Benedict, took place in the factory hall June 21. $14,450 in gold was divided among 289 persons. This number out of 1700 employees had worked from 10 to 34 years continuously with the company, and had qualified as well on the score of diligence and efficiency. The list included three 34-year men, eleven 25-year, thirty-six 20-year, ninety-four 15-year and a hundred and forty-five 10-year men.

Personal

C. W. Johnson, for the past three years general superintendent of the Allis-Chalmers-Bullock, Ltd., shops at Montreal, is now a member of the works staff of the Westinghouse Electric and Manufacturing Company, Pittsburg.

William D. Ennis, for several years engineering adviser to various Rockefeller interests in the Northwest, and since 1905 engaged on special power investigations for the American Locomotive Company, has been appointed professor of mechanical engineering in the Polytechnic Institute, of Brooklyn, N. Y.

Trade Catalogs

W. E. Caldwell Co., Inc., Louisville, Ky. Catalog of tanks, towers and tube. Illustrated, 36 pages, 6x8½ inches, paper.

Northern Engineering Works, Detroit, Mich. Booklet No. 22, illustrating different types of cranes. 28 pages, 3½x6 inches, paper.

The Burke Machinery Co., Cleveland, Ohio. Loose-leaf leaflets of milling machines, drill presses, forges, tapping machine and knockouts. Illustrated.

The Falls Rivet and Machine Co., Cuyahoga Falls, Ohio. Catalog of Wadsworth improved core machines and equipment. Illustrated. 54 pages, 6x9 inches, paper.

Manufacturers

The Dean Electric Company, Elyria, Ohio, is erecting a new plant.

The Torrey Roller Bushing Company, Bath, Me., is enlarging its plant.

The Keystone Bronze Company, Pittsburg, Penn, will erect a new factory.

The United Lead Company, Philadelphia, Penn., will erect a new factory.

The city of Athens, Ala., will double the capacity of its electric light plant.

The Lisle Manufacturing Company, Clarinda, Iowa, will erect a new foundry.

The Carlson Exploration Company, Hibbing, Minn., will build a machine shop.

The Waterbury Castings Company, Waterbury, Conn., is building a new foundry.

The Packard Motor Car Company, Detroit, Mich., will erect a new $100,000 plant.

The Ashton Valve Company, Boston, Mass., will erect a new factory to cost $67,000.

The G. A. Kelly Plow Company, Longview, Texas, will increase the capacity of its plant.

The Canadian Northern Railroad will, it is reported, erect machine shops at Montreal.

The Wetherill Finished Casting Company, Philadelphia, Penn., will erect a new factory.

Longman & Martinez, paint makers, New York City, will put up a new factory in Brooklyn.

The Superior Foundry Company, Cleveland, Ohio, will spend $26,000 on new buildings.

The Akron (Ohio) Manufacturing Company, making oilers and cans, will erect two additions.

The Potomac Electric Power Company, Washington, D. C., will erect an additional power house.

A. L. Cherry & Company, Portsmouth, Va., will build a three-story addition to its wire and pipe plant.

The Barium Lead Manufacturing Company, of Staunton, Va., will erect a plant in Knoxville, Tenn.

The Southern Steel Company, Gadsden, Ala., will erect a forging plant in connection with its steel mills.

The New Departure Manufacturing Company, will build a new brass foundry at its plant in East Bristol, Conn.

The H. H. Franklin Manufacturing Company, Syracuse, N. Y., will erect a five-story addition to its automobile plant.

J. J. Wheeler, Friends University, North Hall, Wichita, Kans, would like catalogs of steam engines and air compressors.

The Arcade File Works, Anderson, Ind., will erect additions to its plant, which will involve an expenditure of $100,000.

The Hassell Iron Works, Colorado Springs, Colo., manufacturing iron fences, etc., is increasing the capacity of its plant.

The Alan Wood, Iron and Steel Company, Norristown, Penn., will build several additions at a cost of about $1,000,000.

The Heine Safety Boiler Company, St. Louis, Mo., has purchased site on which a new $300,000 plant will be erected.

The Kohro Packing Company, Davenport, Iowa, has had plans completed for a new boiler house and ice machine house.

The Manufacturers Brass Company, Plainfield, N. J., will erect a plant for the manufacture of brass fixtures and fittings.

The Talladega (Ala.) Machine and Foundry Company, has been incorporated by W. S. White, W. H. Moore and E. S. Moore.

The Dairy Queen Manufacturing Company, Flora, Ind., makers of cream separators, will move to Lebanon where a new plant will be erected.

It is reported that the Atlanta Steel Hoop Company, Atlanta, Ga., contemplates building a blast furnace at a cost of about $200,000.

Chicago Railway Equipment Company, Chicago, Ill., will erect a new plant, which it is said, will contain 200,000 square feet of floor space.

Jackson Bros. Manufacturing Company, Reading, Penn., will build a new three-story factory. The company manufactures wash machines.

E. A. Sheldon, 53 Lenox Place, New Britain, Conn., is fitting up a small shop for experimental work, model making and special machinery.

The Enterprise Manufacturing Company, hardware manufacturers, of Philadelphia, Penn., has purchased a site near Bristol, where a plant will be erected.

The Herron-Sharp Brass Works, Chattanooga, Tenn., recently organized, has secured permit to erect a shop. Brass castings, etc., will be manufactured.

The Oldendorph Plow Company has been incorporated at St. Louis, Mo. Capital, $100,000. Incorporators, Walter M. Oldendorph, James Solari and others.

The Ottawa (Kan.) Manufacturing Company has been organized to make windmills, etc. Capital, $50,000. E. L. Warner, O. L. Huffman, and others, directors.

Contracts have been let for two additional buildings at the plant of the Remington Typewriter Company, at Ilion, N. Y., which will increase the capacity nearly one-half.

The W. E. Dillard Manufacturing Company, Petersburg, Va., a new concern, will erect a factory to manufacture cross-cut saw handles, etc. W. E. Dillard, president.

The Union Pacific Railroad is contemplating the erection of a foundry and other improvements at its shops in Omaha, Neb. It is said about $100,000 will be expended.

The Stephens (Ark.) Light and Power Company contemplates purchasing a 30-kilowatt generator, engine and boiler and establishing a planing and turning mill.

The New Martinsville (W. Va.) Glass Manufacturing Company, will erect a new factory building to replace the one recently burned. This will cost, with equipment, about $50,000.

It is reported that the Decatur Car Wheel and Manufacturing Company contemplates improvements at the Savannah, Ga., plant.

which will greatly increase the present capacity.

Plans have been completed for the Russell Sage Mechanical and Electrical Laboratory to be erected at the Rensselaer Polytechnic Institute, Troy, N. Y. This will cost about $250,000.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

We desire a few more machines or specialties to manufacture. Box 423, Troy, N. Y.

Machines designed and built. Walter S. McKinney, M. E., Broadway, Flushing, N. Y.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

C. W. Clifford, M. E., working and patent drawings and tracings. 643 N. 44th St., Philadelphia, Pa.

High-grade gray iron machinery castings. Write for quotations. Phœnix Iron Works Company, Meadville, Pa.

Special machinery built to order; let us estimate on your work. Capital Foundry and Machine Company, Frankfort, Ky.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Special machinery to order. Catalog of small engines and boilers and engine castings 10c. Sipp Elec. & Mach. Co., Paterson, N. J.

We will do your manufacturing for you; well established and equipped foundry and machine shop. Emmert Mfg. Co., Waynesboro, Penn.

Well established concern will pay royalty for several good patented machines or tools to manufacture. Emmert Mfg. Co., Waynesboro, Penn.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Company of young engineers, newly organized, desires to bid on drafting contracts, machine work, etc., drafting in all its branches solicited. Address "Engineer," Box 164, AMERICAN MACHINIST.

Draftsmen: Clifford's book of alphabets, for titles, sign painting or show cards, valuable to every designer; limited number only; price 25 cents; write now. C. W. Clifford, 643 Belmont ave., Philadelphia, Pa.

Potter & Johnston 8½x16 automatic turning and chucking machine wanted at once; second-hand machine in good condition, acceptable; communicate with American and British Mfg. Co., Bridgeport, Conn.

A well equipped machine shop and foundry desires to add to its output by the manufacture of articles of brass and iron which would find a ready sale in the South; correspondence invited. Box 122, AM. MACH.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

An old established firm with modern tools and equipment is desirous to communicate with an American firm to manufacture for them in Canada a line of light or medium weight machine work. Box 79, AM. MACH.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th street.

Advice: mechanical, practical and technical; tell me your needs, I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

To manufacturers and others: A resident of Sydney, Australia, will be in New York early in July, desires to obtain a general agency or as representative; weighing appliances and mechanical goods a specialty; references and security if needed, pending arrival. Box 108, AMERICAN MACHINIST.

We have a special proposition for a few bright, energetic mechanics, such as foremen, draftsmen or machinists in different sections of the country; no canvassing or selling of any kind, and, while not interfering with your regular work, pays well for the time taken; we want only practical men who can be depended on to give the little time required each week; further particulars on application. Box 102, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Painter and letterer, 30, wants position as foreman anywhere with machinery or construction firm; hustler; knows his work; now with large firm. Box 140, AMER. MACHINIST.

Young English inspecting engineer desires responsible position; 27 years of age; 2 years English Government inspector, also experience in Germany and India, at present in good position with large Canadian engineers. Box 133, AMERICAN MACHINIST.

CONNECTICUT

Foreman wishes position; accustomed to high-grade duplicate work; gas and gasolene engine work a specialty; executive ability and good handler of men. Box 151, AM. MACH.

ILLINOIS

Toolmaker with technical education and extensive experience at designing special machinery and tools. Box 160, AM. MACH.

Designer, who is a practical, technical and experienced man on machine tools, special machinery and tools for manufacturing. Box 159, AMERICAN MACHINIST.

Superintendent, practical machinist and toolmaker; wide experience on interchangeable work, special machinery and metal specialties; excellent manager of men; can handle big proposition and produce results; high recommendations. Address Box 143, AM. M.

MASSACHUSETTS

Manager or superintendent—practical, wide and successful experience, with good executive ability—desires correspondence from parties in need of an up-to-date, energetic and loyal man; all correspondence strictly confidential. Address Box 114, AMERICAN MACHHINIST.

Wanted—Position as assistant superintendent, chief draftsman or special designer with concern building printing and stereotyping machinery; good, broad experience in this line; any location; we may need each other; investigate. Address Box 137, AM. MACHINIST.

NEW JERSEY

General foreman, excellent toolmaker and machinist, designer of labor-saving devices, open for engagement. Box 158, AM. MACH.

Position as mechanical superintendent by one who has made economy in finishing machine parts a practice and a study. A designer of special machinery and tools. Successful in handling men. Box 142, AM. M.

Eastern man, 34, shop and office experience, designs special machinery, power plants, etc., can handle experimental or production work, systematize manufacture, wants position as engineer or superintendent with some live concern. Box 144, AMERICAN MACHINIST.

Wanted — Position as factory manager or superintendent by one thoroughly familiar with the design and manufacture of gas, gasolene and producer gas engines and producers; capable of producing the best results. Address "Reliable," AMERICAN MACHINIST.

NEW YORK

Young man with 3 years' shop experience desires a position as mechanical draftsman; good detailer. Box 148, AMERICAN MACH.

Experienced designer; printing presses and book binders' machinery a specialty; desires situation. Address Box 76, AMER. MACH.

Draftsman, 5½ years' experience, 2 years shop work, third year student of mechanical engineering at Cooper Union. Box 149, AMERICAN MACHINIST.

Foreman desires change; machine or auto shop, New York; master mechanic, toolmaker, ability to design appliances for quick production. "Hustler," AMERICAN MACHINIST.

Superintendent; high-class, aggressive and energetic, manufacturing, machine building, and foundry lines, good record for reducing costs and raising output. Box 162, AM. MACH.

Chief draftsman of large concern desires change, broadly qualified on automatic machinery and up-to-date in factory details, exceptional inventive ability; expert mechanic. Box 165, AMERICAN MACHINIST.

Foreman, 18 years practice, 8 years as foreman, familar with the manufacture of machine tools, the design of jigs, fixtures, etc., desires a change; New York City or vicinity. Box 161, AMERICAN MACHINIST.

Superintendent and master mechanic of large experience, is open for engagement; technical education; small and medium interchangeable machinery, general manufacturing, gas engines or automobiles; excellent references. Box 152, AMERICAN MACHINIST.

Superintendent desiring change solicits correspondence from machine tool concerns desiring the services of a practical mechanic who can organize shop so as to produce the highest class work at lowest cost; unquestionable references as to ability and character. Box 166, AMERICAN MACHINIST.

Wanted—By man now in executive capacity in eastern automobile factory a position at testing, on the road or in shop; technically well educated and familiar with mechanical practice, design of special machinery and automobile requirements; present salary $100 per month. Box 156, AMERICAN MACHINIST.

Responsible situation wanted by mechanical engineer; age 31; technical graduate, with 10 years' shop and drafting-room experience in general and special machinery; expert designer and inventor; systematic methods; have had charge of drafting room and other work; also experienced with structural work; A-1 references. Box 170, AM. M.

OHIO

Draftsman on gas engines and compressors open for engagement; 7 years' experience, $100; references. Box 139, AMER. MACH.

Screw department foreman open for position well versed on different automatics; first-class toolmaker and designer used to large departments. Apply Box 153, AMER. MACH.

PENNSYLVANIA

Works manager; age 34; married; now employed; first-class references; reasons for changing at interview. Box 127, AM. MACH.

Foreman patternmaker wants reengagement; first-class general experience in drawing, patternmaking, foundry practice and up-to-date methods; best of references. Box 145, AMERICAN MACHINIST.

Factory executive, engineer, manager, superintendent, energetic, successful, experienced in industrial layout and organizaton for maxmum production; member A. S. M. E. Box 141, AMERICAN MACHINIST.

Draftsman—30 years, graduated in Germany, 5 years' experience, especially in hoisting and conveying machinery, 2 years in America, highly recommended for all-around work—wishes to change position. Address "R," Box 121, AMERICAN MACHINIST.

Experienced woman invites correspondence from manufacturers of machine tools, or in any mechanical line, with a view to position as publicity manager; thoroughly competent to handle printing, illustrating, and the preparation of copy. Box 103, AMER. MACHINIST.

Manager of an up-to-date plant desires to change; competent office man, experienced in the detail of manufacture in the foundry, machine shop, pattern shop and drafting room; technical graduate, capable and original designer, intimately acquainted with all the operations of a corporation employing 7000 men; I present an opportunity for a successful business owner to shift some of his cares. Address 218 Locust St., Avalon, Pa.

WISCONSIN

Molder, 34 years of age, 20 years' experience in all classes of work, desires position as foreman or charge hand. Box 146, AM. M.

Mechanical engineer, 4 years' experience in steam turbines, gas engines, general machinery, also good shop experience, wants to change. Address Box 157, AMER. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—Die makers for sheet brass and steel work, accustomed to accurate work; steady employment and good wages to competent workmen. Address with references, experience, etc. Box 123, AMER. MACHINIST.

ILLINOIS

Large company building line of duplex direct-acting steam pumps and hydraulic machinery want a first-class head draftsman; good position for the right man; state experience, age, etc. Adress Box 95, AM. MACH.

Wanted—Thoroughly experienced engineer as chief draftsman for factory employing 500 men and 25 draftsmen in the manufacture of automatic machinery; excellent opportunity for man of exceptional ability and experience. Box 147, AMERICAN MACHINIST.

Wanted—First-class hustling general superintendent for machine works in middle west, employing one thousand men; open shop; splendid labor conditions; a good position for the right man; state experience. Address Box 96, AMERICAN MACHINIST.

MINNESOTA

Instructor in pattern work and carpentry; must be a first-class pattern maker; salary $1000 for 10 months; summer school if desired $150 additional. Address Professor of Mechanical Engineering, University of Minnesota, Minneapolis.

Wanted—An expert mechanic, to design dies, jigs and all up-to-date appliances for making the parts of seeding machines; must thoroughly understand punch, drop hammer and bulldozer dies and forms; must be able to devise ways and means of getting good work in all the departments at the least possible cost; would like a man with some experience in sheet steel press work; also able to make his own drawings. Aply to the Monitor Drill Co., Minneapolis, Minn., giving age, references and salary wanted.

MISSOURI

Draftsman wanted—Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 867, AMERICAN MACHINIST.

NEW JERSEY

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Engineer for machine shop with well established and rapidly growing business; a young, educated, experienced and thoroughly up-to-date man; only those who state age, nationality, experience, references, salary expected, etc., all with full particulars, will be considered. Location about 50 miles from New York. Fine opportunity for the right man. "R. S. K.," AMERICAN MACHINIST.

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Machinery house, well rated, dividend-paying, desires sales manager with $5000 or $10,000. "Machinery," Box 155, AM. MACH.

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OHIO

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National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads
Lang Co., G. R., Meadville, Pa.

Bolts, Coupling
Cleveland Cap Screw Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O

Bone for Case Hardening
Rogers & Hubbard Co., Middletown, Conn.

Books, Technical
American School of Corespondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Philadelphia, Pa.

Boosters
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Horseless Age, New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.

Boring and Drilling Machines, Horizontal—*Cont.*
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadephia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote
Cleveland Wire Spring Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction
Electric Controller & Supply Co., Cleveland, O.

Brazing
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Brazing and Tempering Powders
Phillips-Lafitte Co., Phila., Pa.

Broaching Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Smith Co., Ernst G., Columbia, Pa.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
See Grinding Wheels

Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Manufacturers Foundry Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.
Keystone Steel Casting Co., Chester, Pa.
Krupp (Thos. Prosser & Son), New York.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
National Machine Co., The, Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

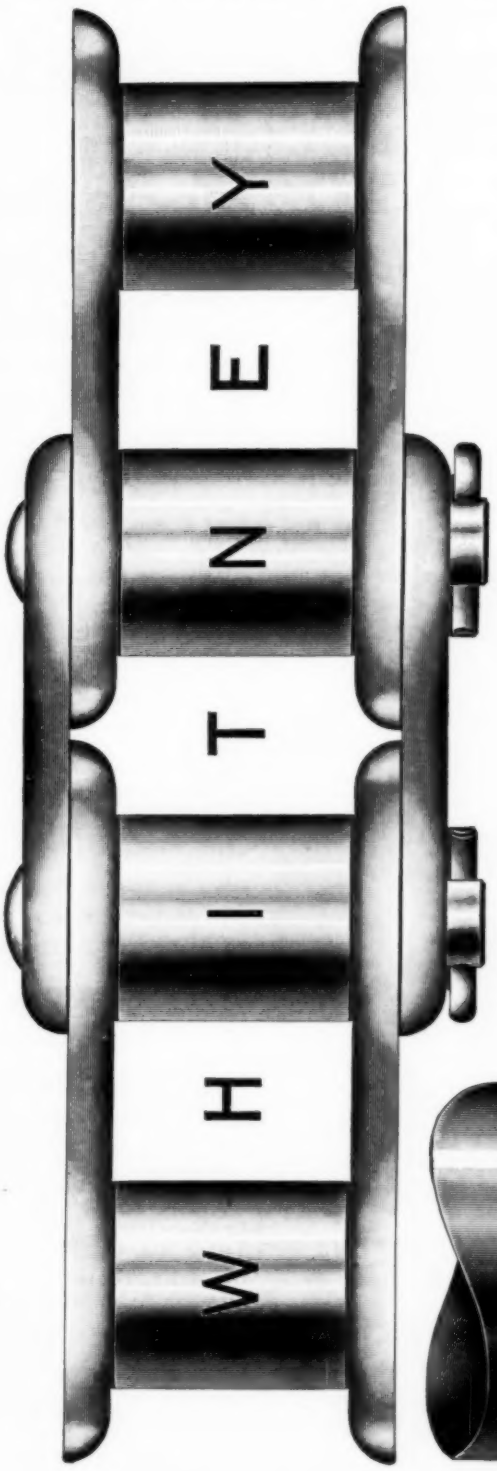
Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

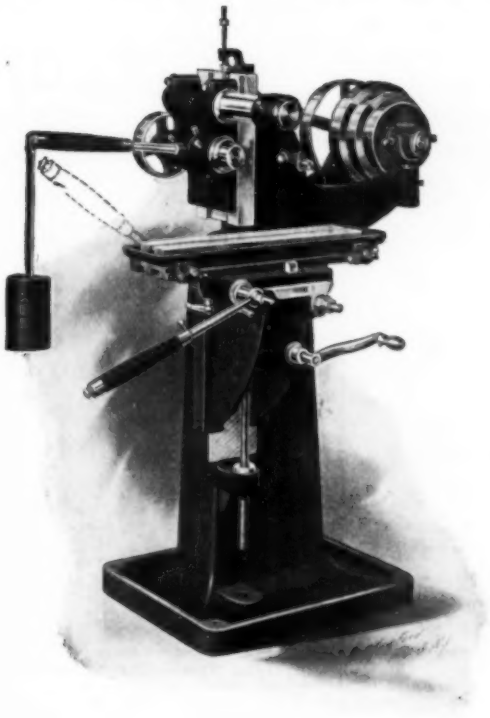
Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.

"WHITNEY" CHAINS

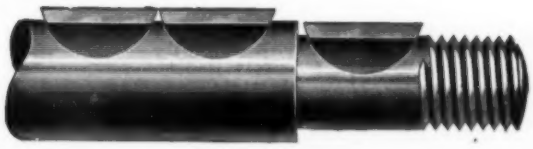
Hand (feed) Milling Machines

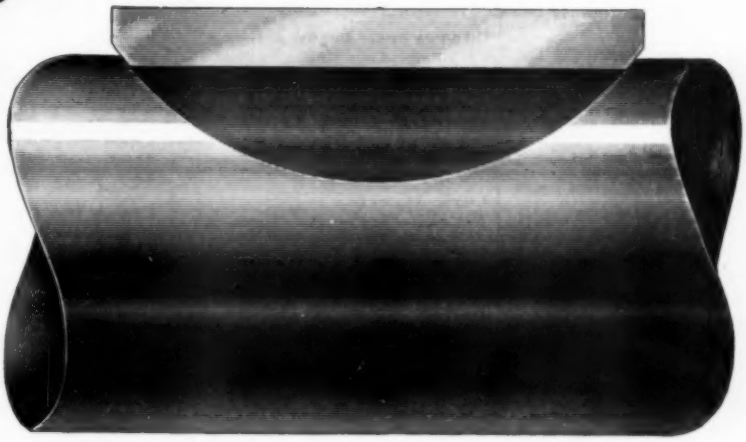
The Woodruff Patent System of Keying





The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Chucking Machines—*Cont.*
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodall-Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Oneida National Chuck Co., Oneida, N. Y.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor, Locks, Conn.
Niles-Bement-Pond Co., New York.
Oneida National Chuck Co., Oneida, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Oneida National Chuck Co., Oneida, N. Y.
Reed Co., Francis, Worcester, Mass.
Skinner Chuck Co, New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction
American Tool & Machine Co., Boston, Mass.
Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co. Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.

Clutches, Friction—*Cont.*
Woods Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic
Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic
Sturtevant Co., B. F., Hyde Park, Mass.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Slushing
Warren Bros. Co., Boston, Mass.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co, New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Cambridge, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts
National Brake & Clutch Co., Boston, Mass.

Corundum
See Grinding Wheels.

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery
Heber & Co., J. R., Brooklyn, N.Y.
Veeder Mfg. Co., Hartford, Ct.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Davis Machine Co., W. P., Rochester, N. Y.
Electric Controller & Supply Co., Cleveland, Ohio.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes,
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, Ohio.
Byram & Co., Inc., Detroit, Mich.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Phila., Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Krupp (Thos. Prosser & Son), New York.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Byram & Co., Inc., Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros, Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Cyclometers
Veeder Mfg. Co., Hartford, Ct.

Diamond, Tools
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, Ohio.
Superior Corundum Wheel Co., Waltham, Mass.

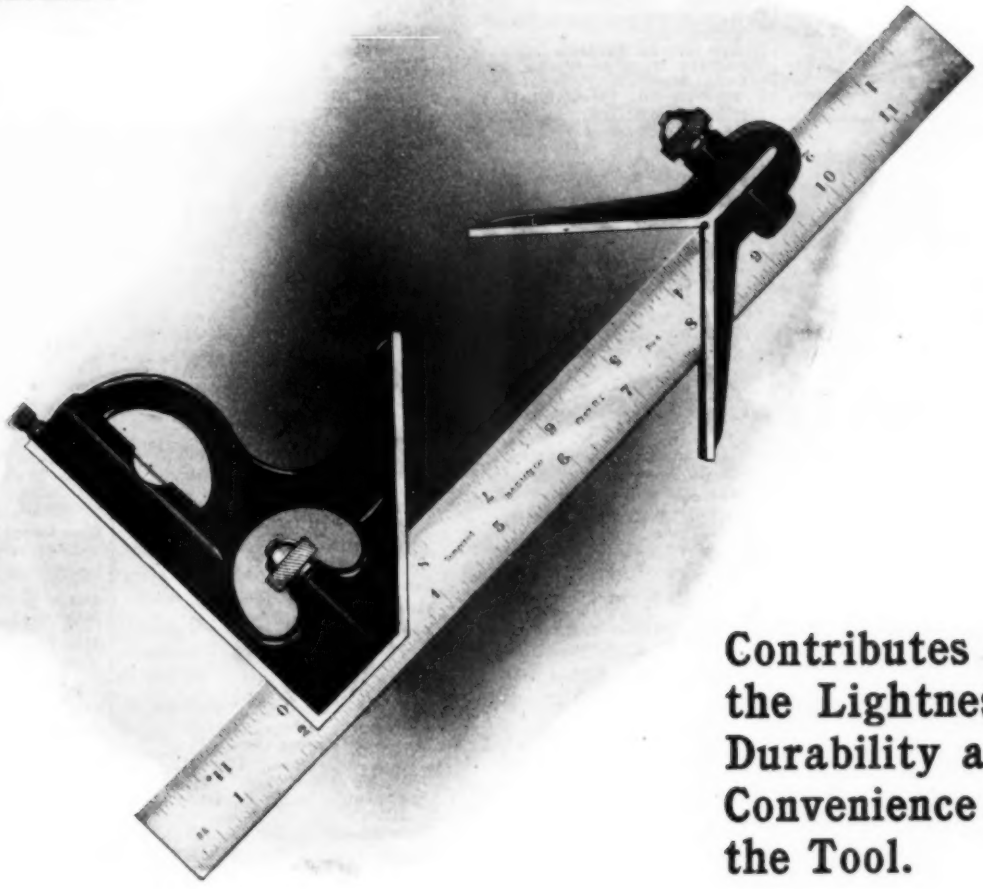
Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Globe Machine & Stamping Co., Cleveland, Ohio.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I., U.S.A.

B. & S. Combination Squares

HEADS OF STEEL,
DROP FORGED,
HARDENED.



Contributes to the Lightness, Durability and Convenience of the Tool.

ANOTHER IMPORTANT FEATURE.

A Round Clamping Groove in Blade admits of use of Stronger Blade and Clamping Bolt prevents dirt collecting in Groove and preserves Accuracy of the Tool.

Dies, Sheet Metal—*Cont.*
Risdon Tool Works, Waterbury, Conn.
Swaine Mfg. Co., Fred J., St. Louis, Mo.
Toledo Machine & Tool Co., Toledo, Ohio.

Dies, Sub-Press
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.
Risdon Tool Works, Waterbury, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Mittineague Paper Co., Mittineague, Mass.
Noyes Mfg. Co., Waynesboro, Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, Ohio
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
National Machine Co., The, Hartford, Conn.

Drilling Machines, Multiple Spindle—*Continued.*
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Reed Co., Francis, Worcester, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Mach. Co., Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, Ohio.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Machine Co., The, Hartford, Conn.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Reed Co., Francis, Worcester, Mass.

Drilling Machines, Upright—*Continued.*
Robertson Mfg. Co., Buffalo, N. Y.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Mach. Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Coates Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Dallett Co., Thos., H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Eectrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Eectric Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Co., Belleville, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.

Electrical Supplies—*Cont'd.*
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
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Crosby Steam Gage & Valve Co., Boston, Mass.
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Crocker-Wheeler Co., Ampere, N. J.
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Automatic Mach. Co., Bridgeport, Conn.
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Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Olds Gas Power Co., Lansing, Mich.
Remington Oil Engine Co., Stamford, Conn.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Marine
Remington Oil Engine Co., Stamford, Conn.

Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.

Engines, Steam
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Garden City Fan Co., Chicago, Ill.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Making a Set of Accurate Index Dials

How a Set of Seven Index Dials Was Originated with the Aid of Some Interesting and Accurate Fixtures

BY F. A. STANLEY

The problem of originating an accurate index dial or plate is one of the most interesting and difficult of the many special undertakings within the province of the toolmaker. Usually the origination of a single dial only is involved; but where there are two or more to be made, each dial is generally handled practically as an independent proposition. If a built-up construction is adopted, the indexing blocks or other members attached to any one of the dials are finished as permanent parts of that particular dial without attempting to treat them as interchangeable members which, if desired, could be applied to any dial in the series without affecting the close degree of accuracy originally provided for.

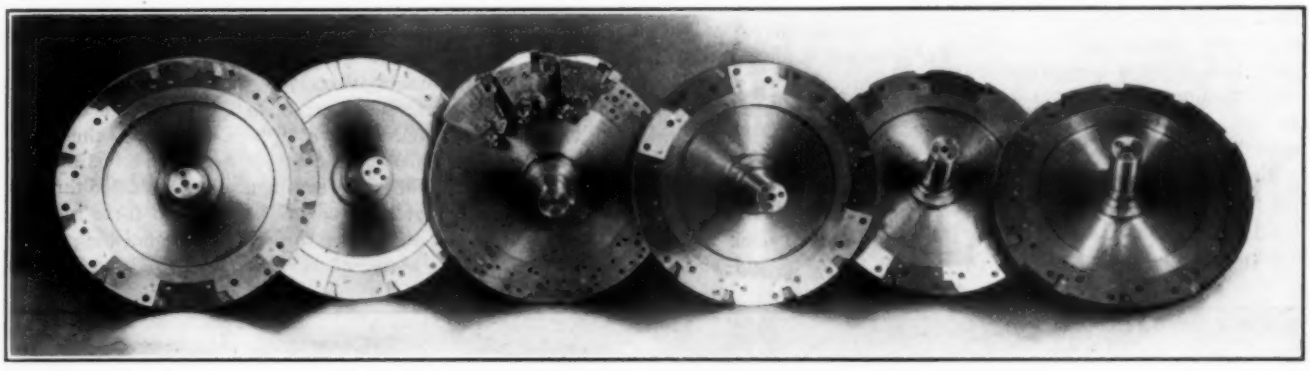


FIG. 1. A GROUP OF ACCURATE INDEX DIALS

It is the object of the present article to describe the methods and appliances utilized in the originating of a set of seven index dials, each of which is provided with twelve hardened and ground index blocks so made as to permit any one of the blocks on any given dial to be interchanged with any of its eleven companion blocks or to be placed in any of the twelve positions or stations on any other dial without this change in any way affecting the accuracy of the dial in question. While there is little likelihood of the index blocks ever being changed while in service, the fact that the method of construction makes it possible to drop any block correctly into any station on any dial constitutes a highly interesting feature of the undertaking, although this feature of interchangeability may of itself be said to have added nothing to the cost of doing the work, as it was, so to speak, one of the natural results incidental to the course of procedure followed in the prosecution of the work.

Application of the Dials

These seven dials were constructed at the experimental shop in New York City of the Remington Typewriter Company. This shop is superintended by George F. Ballou, who is well known to most American Machinist readers in connection with his work in constructing the Rogers-Ballou dividing engine and other precision undertakings of the finest character. Each dial forms a part of an automatic machine used in performing a series of delicate operations upon a U-shaped typewriter part, measuring about 1⅛ inches in length. The index dial, which is mounted on a horizontal spindle, carries on the side opposite the index blocks twelve vise blocks for carrying the work, and at each advance of the dial four spindles located at either side advance the tools which operate upon two sides of four pieces simultaneously. The dial is rotated by a twelve-tooth ratchet on the spindle and is of course held fast by the locking bolt during each operation on the work. The machine once assembled provides for no adjustment either as to center distances between spindles or re-timing of index and spindle movements. The mechanism is constructed to take care of the accurate machining of this particular piece and no loophole is left for improper readjustment of any important member. The operations on the work are of a peculiarly sensitive nature, and it is essential that the successive index movements be very exact in order to assure the proper action of the tools and the necessary degree of precision in the product.

Six of the set of seven dials are shown in Fig. 1; the seventh was in operation in its machine at the time the photograph was taken, hence could not be included in the group. The dial just to the left of the center is represented from the vise-block side. These blocks had been removed from the dials for some purpose and had not all been replaced when the exposure was made. However, the three which are shown give an excellent idea of the method of attaching to the dial; and the larger view in Fig. 2, which shows opposite sides of two of the dials, brings out clearly the toggle arrangement with which each vise block is equipped for gripping the piece of work. The latter, by the way, is fed into the jaws from a table past which the periphery of the dial turns; at the first indexing movement after the admission of the piece a locating device sets the work firmly in place in the holder, the second indexing movement causing the jaws to clamp it fast and hold it securely until after it has passed the series of tools, when the toggle mechanism is again actuated to open the jaws and release the work, which then drops into a receptacle beneath the dial.

The Index Blocks

The manner in which the twelve hardened and ground index blocks are fitted to the dial is well illustrated in Fig. 2. As will be noticed, they rest on an annular shoulder or ring formed on the face of the dial, and each is secured by two dowel pins and two fillister-head screws. The index notches are of the well known form, having one radial face and an opposite face at an angle of 30 degrees; the notches are formed between the unbroken radial end of one block and the 30-degree shoulder provided on the block adjacent.

The disk on which the blocks are carried is of cast iron, 16¾ inches in diameter and finished all over, with a hub about 5 inches long bored to 2½ inches and keyed on a hardened and ground steel arbor on the opposite end of which is secured the ratchet for rotating the dial. A detail of the blank disk finished and ready for the blocks is shown in Fig. 3. A block detail is represented in Fig. 4.

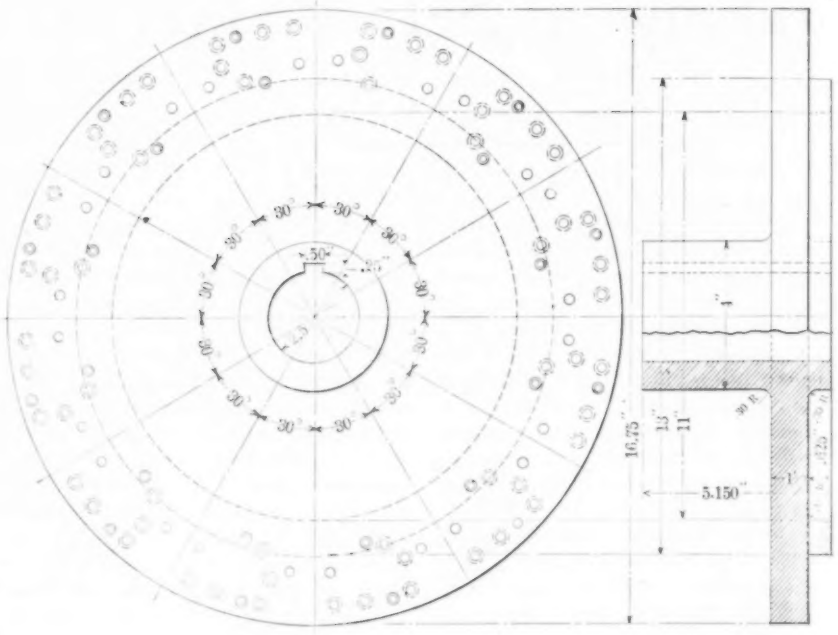
Roughing Out the Index Blocks

These blocks are approximately 4¼ inches long over all, and ⅝ of an inch thick; the material is Jessop steel. They are secured to the disk by two ¼-inch straight dowel pins fitting holes *A A*, and two ⅜-inch fillister-head screws fitting soft-steel bushings at *B B*, which are pressed firmly and permanently into place. The object of these bushings is to provide a means of accurately locating and sizing the holes for the screw bodies and heads without the necessity of grinding these holes out after the hardening of the blocks. Therefore in drilling the blocks, holes for the bushings were drilled, reamed and counterbored, and after the blocks were hardened the unhardened bushings were pressed into place, to be again drilled, reamed and counterbored for the screw bodies and heads in a later operation.

The 84 blocks necessary for the seven dials were cut roughly to length, machined carefully on the sides to within a few hundredths of the required thickness, then placed nine at a time on the lathe face plate shown to the left in Fig. 5. Here, while held by straps, a few of which are represented in position, the outer and inner edges were turned to roughing dimensions, preparing the blocks for the drilling operations to be performed in the jig. This jig will be seen at the center of the group of tools in Fig. 6.

The Drilling and Reaming Jig

It should be stated here that the index blocks were passed twice through this drill jig. For the first operation in the jig the two pins shown at one side of the center were removed, the bushings in which they are shown in the half-tone being utilized for drilling the two straight dowel-pin holes *A A*, Fig. 4. The work during this first operation in the jig was located against hardened-steel plates at the side and end. The dowel-pin holes were drilled and reamed a few thousandths under size and the two holes at *B B* for the bushings to receive the fillister-head screws were drilled, reamed and counterbored nearly ⅛ inch larger than the actual size of the screw heads and bodies. At the same setting a hole was drilled through at one end of the block to form a clearance space to facilitate the finishing of the 30-degree bevel surface at *C*. After this


30°
30°
30°

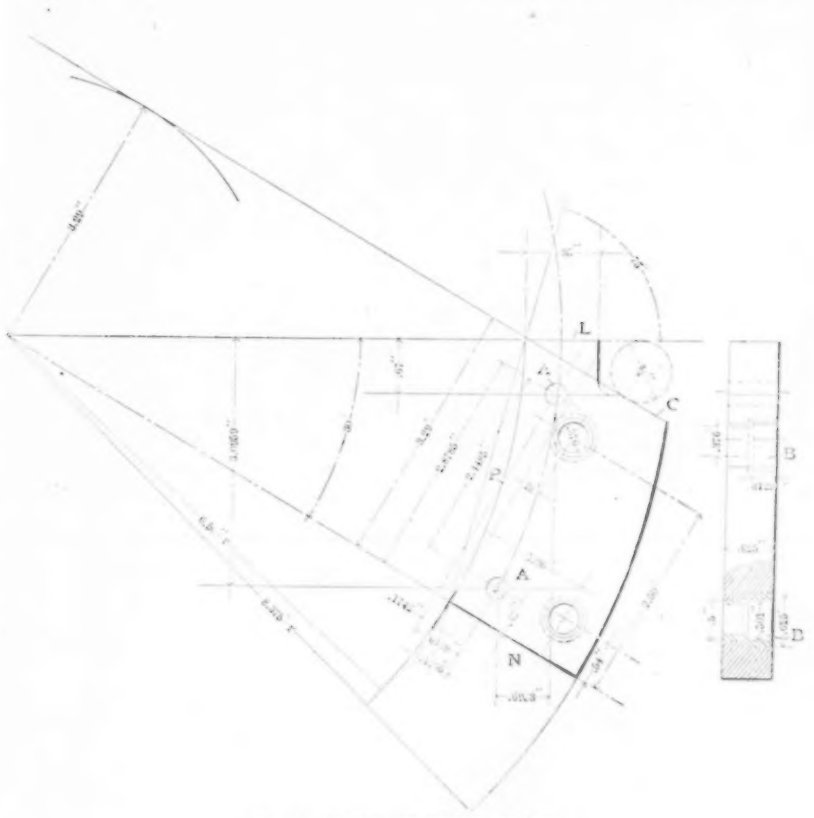


FIG. 4. DETAIL OF INDEX BLOCK

end had been shaped out and the blocks had been hardened, two soft-steel bushings turned on an arbor slightly smaller than the ⅜ screw bodies were pressed into the two enlarged holes referred to above; the blocks were then ready for grinding on the faces, this being accomplished on the magnetic chuck in the surface grinder, where the faces were finished parallel and the desired thickness of 5/8 inch obtained. The second operation performed in the drill jig consisted in reboring and counterboring the soft-steel bushings to suit the fillister-head screws; it will be referred to again at the proper point in this article. Before leaving the jig for the moment, however, attention should be drawn to the fact that it is so bushed from opposite sides as to permit drilling of the work from one side and reaming from the other.

After the index blocks had been handled in the jig for the first time, the two ¼-inch holes *A A* in each were utilized as locating and reference points to facilitate the accurate finishing of various surfaces. It was therefore essential that these two holes in each of the 84 blocks should be as accurately spaced and as straight and true to size as it was possible to make them. This necessarily involved some exceedingly nice grinding and lapping operations in the case of each pair of holes, and some details of the procedure should be of interest here.

The Master Templets

First a soft master templet was made, which was used in making a hardened master, which was in turn utilized for locating the work properly on the bench lathe for the accurate finishing of the two ¼-inch holes. There are several methods known to the toolmaker for spacing holes accurately in a jig or a templet, some involving the use of buttons and indicators on lathe or miller, others depending on entirely different means for attaining the required degree of accuracy. One method, which is simple though highly satisfactory, makes use of the dial readings on the screw of the milling-machine table, yet does not depend at all upon the accuracy of the screw for the nicety of the results obtained.

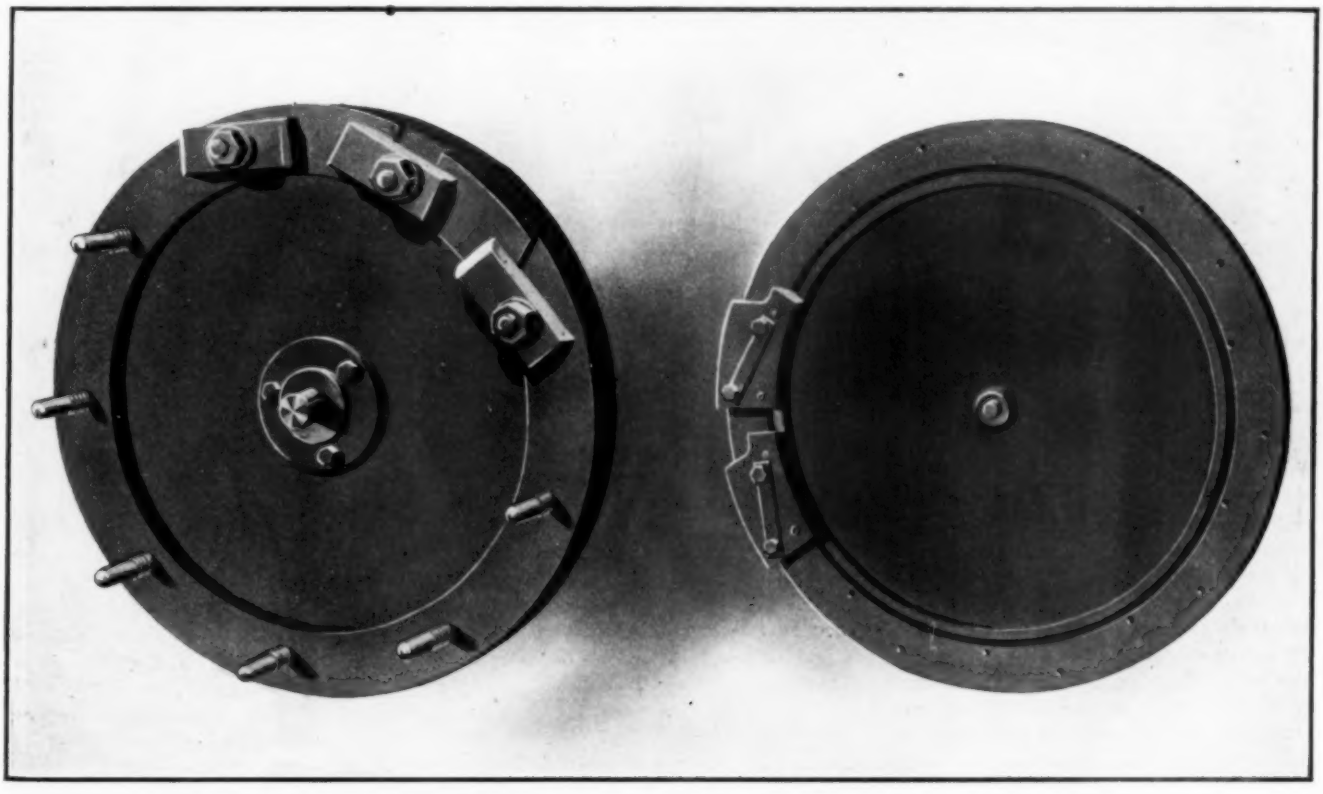


FIG. 5. FACE PLATES FOR TURNING AND GRINDING THE INNER EDGES OF THE INDEX BLOCKS

Thus in boring say two ½-inch holes 2 inches apart in a plate, this method would involve first the securing of the work to the table, and the boring of one hole to a size somewhat below ½ inch. Before starting this hole it is assumed that the backlash is out of the screw, the table and other members snugly adjusted and the graduated dial set at zero. Now the table is fed along to a distance of 2 inches, as recorded by the dial on the screw, and the second hole bored to the diameter of the first. Two plugs are inserted in the holes, and a careful measurement made over them with micrometer or vernier to determine the actual variation from the required center distance of 2 inches, the diameter of one plug, of course, being subtracted from the reading of the instrument to give the reading for center distance. Say the holes are a thousandth or so too near or too far apart: The table is readjusted in the required direction by the desired amount, and the hole rebored to the right size, when, if desired, another plug may be put in for a second test measurement. If the center distance is now correct, the table is moved back by the screw to bring the first hole into position for reboring to size. In running the table back, the screw is turned some little distance past the zero mark to which the original setting was made, and then turned ahead again until the dial is once more at zero. This takes out the backlash and the table is again in the position it occupied at the time the first hole was bored undersize. This hole is now rebored to ½ inch, and if the customary care has been used in the manipulation of the machine and boring tool, the two holes will be found to be correctly located relatively to each other.

This method as outlined was the one adopted in boring the two important holes in the soft templet for the index blocks, these holes being made 7/16-inch diameter and to the exact distance apart as computed from the drawing Fig. 4. From this templet, which was about ⅜ inch thick and 2½x4½ inches over all, a block of the same size, but about ⅝ inch thick, was laid out for two ⅜-inch holes, which were drilled a little undersize. Two other holes were drilled, corresponding in position to two tapped holes in the thinner templet, these latter holes being adapted for a couple of screws to be used in fastening the two templets together. Also two holes were tapped in the thicker templet to allow the index blocks to be attached later on.

The ⅝-inch templet was afterward hardened and ground parallel on its faces, and was then ready to have the two holes corresponding in position to the dowel-pin holes in the index blocks ground out to correct size or ⅜ inch, and to correct distance apart. This operation was performed in a bench lathe by the aid of a diamond charged grinding disk.

Correcting the Hardened Master

The two templets were put together, the hard plate on the soft one as indicated at *D* and *E*, Fig. 7, and the two screws put in to hold them securely, the holes to be ground out in the hard templet *E* being located as nearly central as possible over the holes in the soft master *D*. The face plate *F*, of the lathe, was first carefully trued up in place on the spindle and scraped flat to a surface plate; the hole bored in its center was fitted with a steel plug *G* which, after being put in place, was ground at the outer end to fit snugly in the holes bored in the soft master templet *D*. The two templets were then put on the plate with the master *D* slipped over the locating plug, a couple of straps holding the two templets in place. A counterbalance was put on the face-plate and in order that there should be no danger of the weight springing the plate when clamped in place its under surface was carefully scraped to a good bearing prior to mounting on the plate. The general arrangement of the work and face plate was then as indicated in the sketch in Fig. 7. The grinding attachment used on the job is seen to the right of the face plate in the group in Fig. 6.

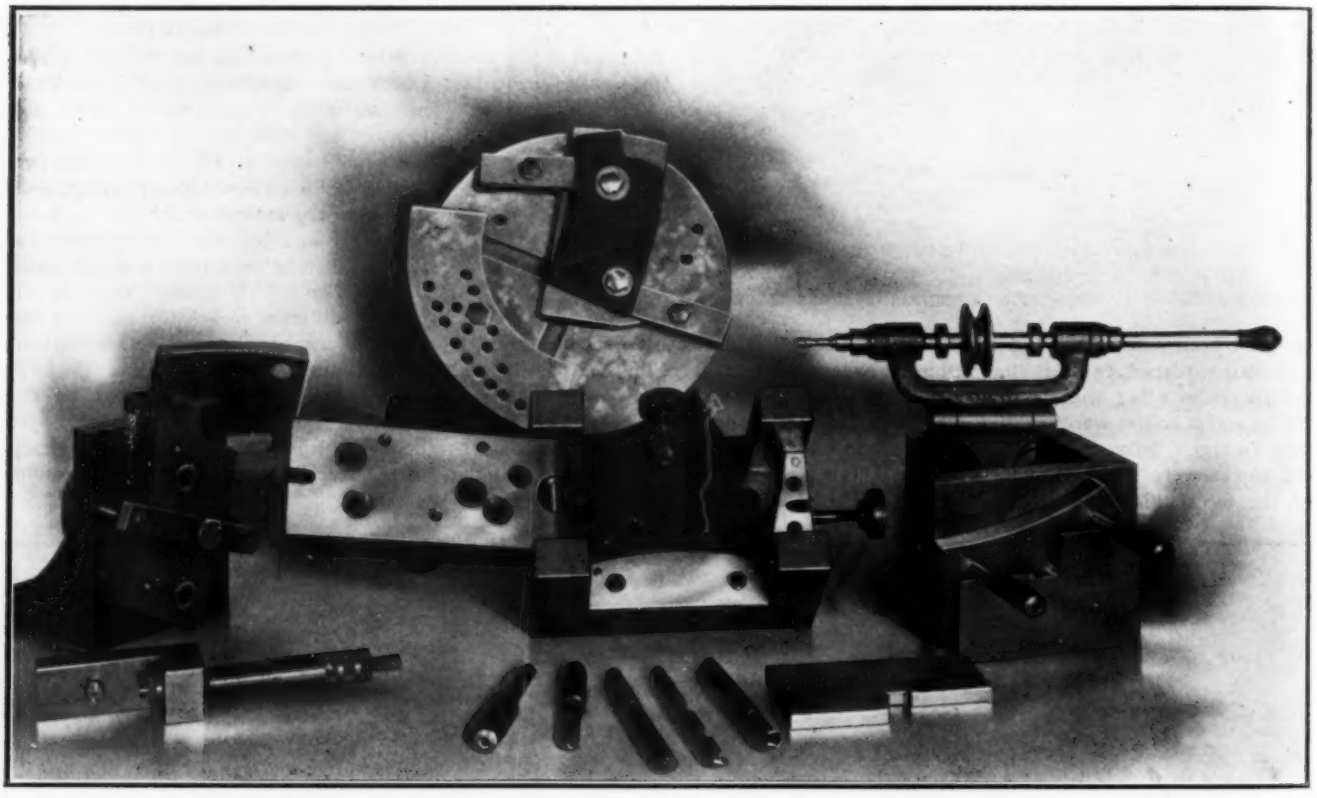


FIG. 6. A GROUP OF INDEX-BLOCK TOOLS

After hole *H* had been ground out with the diamond-charged wheel to within about 0.0001 inch of the required size, both templets were removed from the face plate, and turned end for end to bring hole *I* into position for grinding. It is evident that this method of locating hardened templet *E* by means of the accurately made soft master *D* assured the correct center distance being obtained between the two holes in *E*.

After the two holes had in this way

been brought to within about 0.0001 inch of correct size, the hardened master was placed in a sensitive drill press, the table of which was carefully squared up; with a copper lap mounted on a spindle running true in the chuck the holes were lapped out dead to size, the master now being ready for its work of locating the index blocks on the face plate so that their dowel-pin holes could be ground out to ¼ inch.

Grinding out the Holes in the Index Blocks

In locating an index block on the hardened master templet, two plugs with bodies fitting the holes in the latter and with the ends very slightly tapered were pushed in from the back of the master as shown in Fig. 8, the taper ends of these plugs *J* entering the index block *K* far enough to center it even though the original distance between the dowel-pin holes had changed somewhat in the hardening operation. Two screws were then put in to secure the index block to the master templet *E*, and after the locating plug at the center of the bench lathe face plate had been reground to the size of the two locating holes ground out in *E*, the work was placed on the face plate. This plate, with the hardened master templet and an index segment clamped in position, is shown just behind the jig in Fig. 6. The two ¼-inch holes in the index block were ground out in the bench lathe in the same way as the holes in the master plate were treated, and a very slight amount was later taken out in the lapping under the drill spindle to bring the holes dead straight and to the size of the standard plug. The 84 blocks in the series were put through this process one at a time, and some idea of the care taken in the work may be obtained from the fact that no less than two months' time was required in the finishing of the 168 holes.

Fixtures Used in Grinding the Ends of the Blocks

To hold the index blocks in the proper position for grinding the ends to the radial lines at an angle of 30 degrees with each other and the proper distance from the dowel-pin holes, two small angle plates shown in the half-tone Fig. 6 were made. These were finished with great care to bring the surfaces and edges perfectly square with one another. After the angle plates were made, came the problem of locating in each, two pins upon which to locate the work from the ¼ holes ground out in the manner described.

The angle at the left of the group in the engraving is shown with an index block in position for grinding the shorter radial end. The correct location of the pins in this case was obtained as follows:

Reference to the detail of the index block in Fig. 4 will show that the various dimensions given include a measurement —0.6953 inch—between the center lines of the two dowel-pin holes *A* drawn perpendicular to the edge *L* to be ground. A templet like *M*, Fig 9, was made having an offset corresponding to this dimension, this templet being ground and lapped on the upper and lower edges to bring these parallel and give the exact drop required. The angle plate was placed on its edge with the templet *M* in front, two plugs fitting the ¼-inch holes in an index block were put into place and the block itself placed against the face of the angle plate with the two plugs resting on the edges of the templet as shown in the sketch. The index block was then carefully clamped to the angle plate and the plugs removed. The job was taken to the sensitive drill; a spot drill whose body was a nice fit in the holes in the index block and whose cutting end was flatted and point thinned down to give a neat cutting edge was passed through the index holes in the block to spot the surface of the cast-iron angle plate. A slightly smaller twist drill was then run completely through the angle plate, leaving a small amount of metal to remove by reaming. The reamer which finished the holes was made a close fit in the index-block holes and adapted to cut on the end only. This reamer and the spotting drill will be seen in the foreground of Fig. 6. When the index block which thus served as a jig was removed, two hardened, ground and lapped pins were put into the angle plate, and with the addition of a swinging clamp for securing the work the angle-plate fixture was ready for use in the surface grinder. In use it was of course placed upright, as indicated in the half-tone Fig. 6, bringing the surface *L* of the work to be ground to the top, and parallel to the base of the angle plate.

In arranging the other angle plate or fixture for holding the index block for the grinding of the longer radial surface *N*, Fig. 4, a similar method was followed, another templet *O*, Fig. 10, being required in which the amount of the drop at the edge equaled 0.6108 inch, the distance between the dowel-pin holes drawn perpendicularly to the longer edge *N*. This angle plate is shown in Fig. 10, also in Fig. 6, with an index block in front supported on its templet ready for clamping preliminary to the spot drilling, drilling and reaming of the holes for the ¼-inch locating pins.

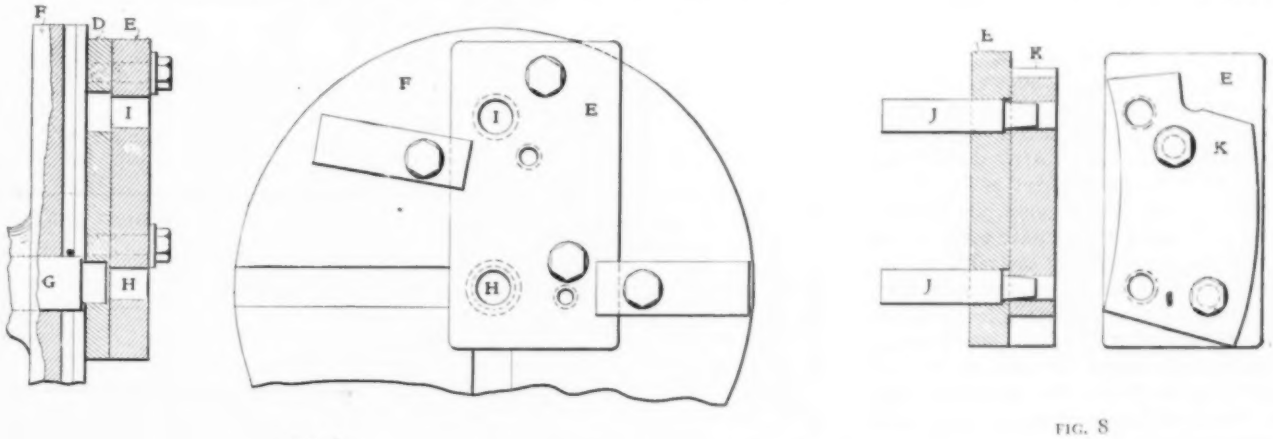


FIG. 7 FIG. 8

LOCATING THE WORK ON THE BENCH-LATHE FACE PLATE

Application of the Fixtures

These angle plates used as grinding fixtures formed an excellent means of testing the accuracy of the locating holes in the index blocks, for the slightest deviation from the center distance with the holes lapped dead to size would have prevented the blocks in question from going into place on the fixtures. The accuracy obtained in the spacing of the work is indicated by the fact that every one of the 84 blocks fitted properly over the pins and for that matter would go either side out over the pins on either angle plate.

On these two fixtures in a Brown & Sharpe surface grinder the ends were brought to the dimensions given in the detail Fig. 4, from the dowel-pin holes. Measurements were obtained by means of the special micrometer gage shown in the foreground of Fig. 6, the pin in this gage fitting the ¼-inch holes in the work and allowing the end of the spindle to come down squarely on the end of the piece. A vernier plate was attached to the bracket behind the hand wheel for adjusting the wheel slide of the grinder so that

the graduations on the hand wheel reading to thousandths could by the vernier be read to ten-thousandths. By means of this attachment very fine adjustments of the cut were possible, so that when the work left the grinder it was correct so far as the ends were concerned. The 30-degree surface *O*, Fig. 4, on the index block, corresponding to the sloping side of the lock bolt, being parallel to the end *N*, was ground by resting the block on the latter end and clamping against an angle plate.

Grinding the Inner Curve of the Blocks

Now we come to the grinding of the index blocks along the inside curve *P*. For this operation the face plate shown to the right in Fig. 5 was made. This plate was fitted to a lathe, carefully trued up in place, and the plug fitted at its center ground true to an even dimension. The cutting of the annular slot for locating the work constituted the most difficult part of the undertaking. The center line of this slot is on a radius of 6.95 inches in accordance with the figures on the detail sketch of the index block. The width of the slot being of no importance of itself, every attention was paid to getting its actual center the exact distance from the center of the plate. After the slot had been cut with the tool set as closely as possible at the desired point, the distance from both inside and outside edges of the slot to the outside of the central plug, was measured, and the actual deviation from the desired radius was easily learned by a simple calculation. The tool was then adjusted to dress out one side of the slot according to whether the radius was long or short, and measurements were again taken. After a few trials a perfectly concentric slot was produced whose center line was exactly to the required radius, and whose sides were exactly parallel.

A series of pins was next made with bodies fitting the ¼-inch holes in the index blocks, and with heads fitting the annular slot turned in the face plate. Ten blocks were then mounted on the plate at a time in the manner indicated in Fig. 5, a series of holes being drilled and tapped in the plate for the reception of the screws for holding the work in place. A grinding attachment rigged up on the lathe completed the outfit, and the grinding out of the inside curve of the blocks was a comparatively simple matter, although, naturally, the internal diameter measured across from block to block had to be gaged with considerable care.

Second Operation in the Jig

After leaving this fixture the blocks were returned to the drill jig, where the holes in the soft-steel bushings were brought to size, and counterbored to the size called for in the drawing. In this second operation in the jig the work was located over the two hardened pins shown in the view in Fig. 6, and this again was a good test of the accuracy of the workmanship on the pieces as well as on the jig itself. The bushings originally used in the drilling and reaming of the ½-inch holes were changed for a pair suitable for the 0.376-inch holes, to which the soft bushings for the fillister-head screws were finished in this operation; drilling and reaming being accomplished from opposite sides of the jig. Upon counterboring the soft bushings to 0.501 inch, the blocks were ready for assembling on their dials.

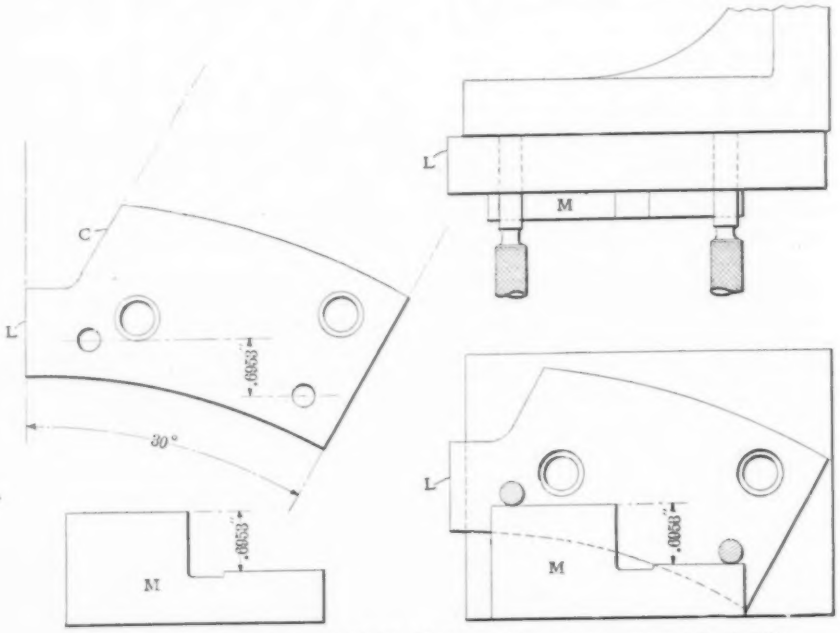


FIG. 9. LOCATING INDEX BLOCK ON ANGLE PLATE FOR GRINDING SHORT END

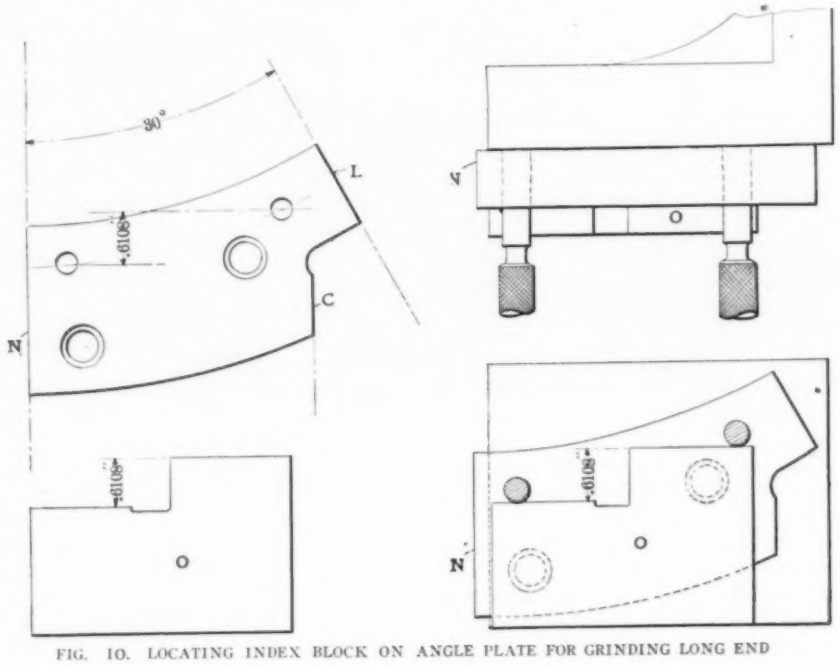


FIG. 10. LOCATING INDEX BLOCK ON ANGLE PLATE FOR GRINDING LONG END

Assembling the Index Dials

This operation was accomplished with the aid of the cylindrical skeleton fixture shown to the left of the drill press in Fig. 11. The blank dial was placed in this frame right side up and eleven blocks carefully cleaned of all dirt and lint placed approximately in position on its face, drawn up to one another and lightly pressed by their set-screws in the periphery of the fixture. The twelfth index block was then placed in the gap left in the series, and, in the case of each dial, this last block when slipped in came just in contact with its fellows, and yet allowed a thickness of 0.001 inch tissue paper to be drawn out from between each end of the curved inner edge or arc of contact, and the annular shoulder on the disk to which the blocks were fitted. This means that when the screw was brought against this last block it set the entire series of indexing segments snugly together ready for the drilling of the disk on which they were mounted.

Before starting operations in the drill press, the table was squared up and the drilling and reaming of the dowel-pin holes and the drilling and tapping of the holes for the fillister-head screws were proceeded with; no pains being spared to insure the accuracy of the results. The holes were all spotted by the spot drill, and the pin holes were drilled through with a slightly smaller twist drill and reamed with a reamer fitting accurately in the holes in the index block and cutting on the end only. The drilling and tapping of the other series of holes were done carefully and no opportunity was given either drill or tap to "run" during the process. The dowel pins used were hardened, ground and lapped straight and true and to size, and the screw holes in the blocks provided only 0.001 clearance for the bodies and heads of the screws, so the necessity for careful handling of the work will be obvious.

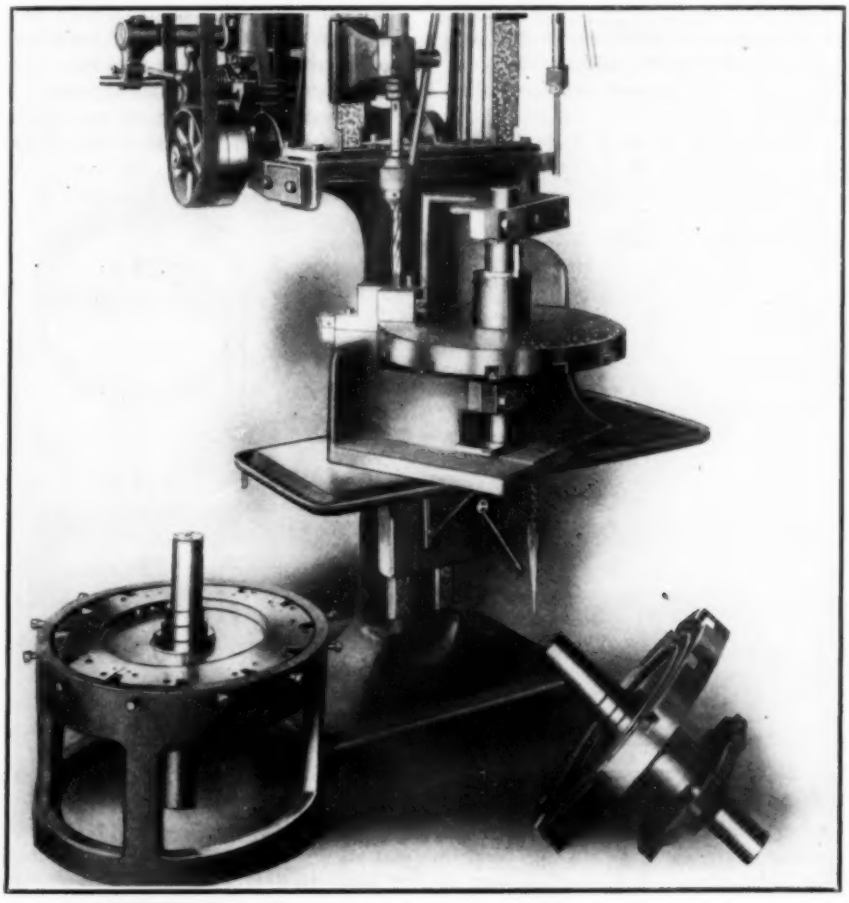


FIG. 11. THE ASSEMBLING FIXTURES

With the pins and screws in place the job was ready for the final operation of bringing the outside of the index blocks to the required diameter, which operation was readily performed by mounting the dial bodily in the grinding lathe.

This completed the work on the indexing segments. To be fully appreciated they must be seen and tested by the observer, who will not fail to admire the beautifully sharp, clean joints of the index blocks when examined under a glass, and the exquisite fit of the different blocks when removed from their places and tested on the several fixtures which aided in their production. The blocks slide over either pin in either of the surface grinding fixtures absolutely without shake, and yet pass with the same nicety of fit and either side out over the two pins which constitute the locating members on these fixtures. They fit either side up over the pins in the drill jig; they measure alike over every point where accurate measuring instruments can be applied; and there is no index block in the set of 84, but what can be removed from its dial and put into the place of any other block on any dial with the certainty that it will fit at every point.

Putting On the Vise Blocks

In conclusion reference may be made briefly to the fixture shown on the drill press, in Fig. 11. In this view the work is shown with the reverse side of the dial up, as actually handled while the vise blocks for carrying the typewriter parts through the automatic machine were being located in position. The fixture was constructed with a locking bolt fitting the index notches of the dial itself, so that the latter might be locked at the different points, as it was turned to bring one section after another under the drill spindle. In designing the device, provision was made for clamping the vise block to be attached, to a positive locating block fixed in the proper position relative to the locking bolt at the under side; with the vise block thus held fast, the spot-drilling, drilling, reaming and tapping operations were carried along with the same degree of care as was employed in the case of the index blocks. As will be noticed, the engraving shows the dial completely drilled. It was completed some time before the photograph was taken, and was merely set up in the fixture with only one block in position to indicate the method of handling during this operation.

Setting the Miller Knee for Boring Work Centrally

By Geo. E. Gray

It is sometimes required to set the miller knee so that the centers of spindle and index centers intersect for drilling holes through the center of round stock at right angles to the axis, etc. Most millers are provided with an index line on the column for this purpose, which answers very well for comparatively rough work. The method hereafter described will, if carefully followed, give extremely close results. It can also be used on square or rectangular work held in the vise.

Hold the work to be operated on in the chuck, vise, or on centers, spread a thin layer of chalk or prussian blue on the upper and lower sides, and hold the reamer or drill in the spindle chuck.

Raise the knee very carefully until, when moving the table back and forth, the revolving tool (drill or reamer) just runs off a thin streak of the marking material on the work. Replace the marking and adjust the hight of the knee several times to get the exact lowest position at which the marking is rubbed off, and set the index collar on the screw to zero.

Now run the table back clear of the tool and raise the knee a distance approximately equal to the diameter of the work plus the diameter of the tool (drill or reamer) and repeat the operation already described on the lower side of the work, adjusting the hight until the highest position is found at which the marking is rubbed off, taking care to move the screw in the same direction as in the previous adjustment to avoid lost motion. Now take the reading for the second setting and readjust the knee to the exact halfway position between the two settings, and the machine is now set correctly to drill exactly through the center of the work. Of course it is apparent that it is absolutely essential that all readings and settings shall be done with the screw moving in one direction to avoid backlash.

Oxy-Acetylene Blowpipe Welding

Use of Method in Making Reinforced Tubes for Automobile Work, Its Possibility for Boilers and the Reasons for Its Intense Heat

BY W. H. BOOTH

Welding by means of the acetylene oxygen blowpipe, to which my attention is recalled by the article by F. H. C. at page 734, is known on the other side as autogenous welding. I understand that it has come into quite considerable use, especially in France, whence comes the inventor of the system, M. Fauché. I attended a demonstration of the blowpipe in London some few months ago, and found that the acetylene was being manufactured in the usual method from carbide, but it was not used under pressure. The oxygen was obtained in cylinders in the usual way, being manufactured by that process which converts barium oxide into peroxide and then drives off the extra atom of oxygen. Thus oxygen is obtained direct from the atmosphere and of sufficient purity for commercial purposes. Its entry to the blowpipe is so devised that it induces the acetylene to flow without risk of getting back to the acetylene vessel.

In the course of the demonstration several things were done for me in order to demonstrate the capabilities of the invention. In the first place tubes of steel were welded circumferentially. The tube ends were cut to a bevel, as in Fig. 1, and the tubes laid in a V. With the blowpipe in one hand and a stick of iron in the other to serve as solder, the operator melted a drop of iron into the V groove between the bevel ends of the pieces to be joined, at two or three places round the circumference. This held the tubes firmly together. Then the flame was applied to the junction, which was gotten up to a molten condition, and iron was run into the groove a bit at a time, until the whole of the circumference had been thus welded up.

The temperature of the combustion is so very high that some of it can be dispensed with, and advantage is taken of this to diminish the supply of oxygen to a point less than is necessary for chemically perfect combustion of the acetylene. The result is that partial oxidation of the carbon gives rise to the production of a portion of carbonic oxide which, when hot, is very greedy of oxygen and reduces the effect of the flame. No iron oxide is formed as a consequence, and the finished weld looked like a succession of pools of solidified iron free from scale and perfectly metallic.

Testing the Welds

For many purposes the weld as made would be quite sufficiently finished, but for other purposes it may be rotated against a stone or emery wheel and dressed down to the true circle of the pipe. I took the finished weld and had the pipe hammered on an anvil with a sledge, flattening it and bending it; failure did not take place at the weld. Next, a pipe was split longitudinally and similarly welded and flattened; still it did not give way in the weld. The junction is scarcely to be called a weld, because the metal is absolutely molten, and the filling stuff from the solder stick is run liquid upon the heated surface-molten edges to be joined.

As a test of the intensity of the flame, a corner was melted off a fire-brick with very little trouble, the brick dissolving in the flame like sugar in hot water, and dropping liquid upon the bench. Next, a lump of calcium carbide was exposed to the flame. This carbide, made as it is in the electrical furnace, is very infusible; yet it also ran down liquid, and when cold I took the pieces that had been melted and threw them into some water on the wet stone floor. Gas came off and I ignited this gas with a match. It burned freely. The carbide had not been changed by melting.

In March last I heard of Verschaves' patent bicycle and motor-chassis tubes and frame bars. I went over to Paris, as I was anxious to see how they were made so good and sound and from such thin material; for though the Cloisonné tubes have one or more longitudinal diaphragms and are stronger than plain round tubes, they are much less in weight than a plain tube, for example, weighing 8 ounces where a Cloisonné tube weighs only 5½ ounces, and so on, a 1.57-inch tube Cloisonné weighing only 92 ounces where the plain tube weighs 135 ounces. I found that the tubes are entirely built up from plain strip, the material being folded into semicircular form, as in Fig. 2.

Making Tubes from Flat Strips

Between the two half or nearly half cylinders, the long central diaphragm plate is laid. This has a breadth somewhat greater than the outer diameter of the finished tube. The three parts were assembled in vises fixed to a long lathe-bed or similar bed shears; the vises were special, carrying jig jaws somewhat as in the figure, so arranged that the longitudinal plate was held with the right amount of projection at each side of the tube. Then when thus assembled, the blowpipe flame was run with considerable rapidity along the upturned projecting edge of the flat diaphragm and supplied the stock necessary to fill the angular space between the plate and the edges of the half circles. When complete the weld is perfect, and a truly circular tube is the result.

I tested several chassis with and without the Cloisonné tubes. The heavy chassis of plain tube could not be lifted from the floor by one corner while a man stood on the opposite side bar without twisting considerably. A similar test with Cloisonné tube chassis was made. In each case lifting by one end corner brought the whole chassis squarely up without twist or wind, the two sides coming up rigidly parallel. Not merely are the longitudinal diaphragms welded in by

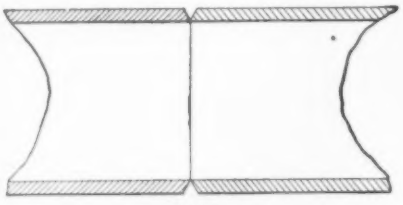


FIG. 1

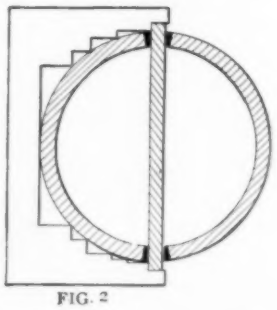


FIG. 2

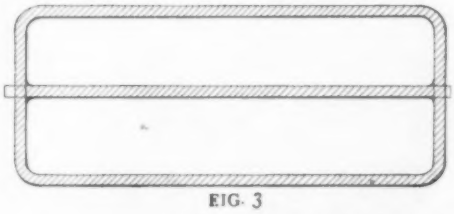


FIG. 3

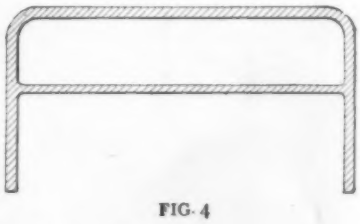


FIG. 4

HOW TUBES ARE BUILT UP WHEN BLOWPIPE IS USED

acetylene, but the whole of a chassis is welded up into a solid frame without a single rivet. Such is the capacity of the blowpipe to do good work that for the 24-horse-power frame an economy of one-third the weight is secured, and for heavier chassis about a half is economized. Various forms of Cloisonné tubes are thus made, some having three longitudinal pieces arranged as a triangle inside a circle; others have a simple cross, while a common form for motor-car chassis is as in Figs. 3 and 4. In Fig. 3 the dotted lines show how the middle web is placed between a pair of channel bars. In Fig. 4 the same system is followed, this section being built up one channel, one wide flat bar and the two outer projecting flanges.

No Danger of Spoiling Work

In each case the extra stock for melting is on the edge of a vertical plate. The autogenous welding has thus at once come into use for one of the newest of industries and serves to give to the steel chassis the much wanted rigidity of which this stood so much in need. What surprised me was the rate of progress made in welding, and also its certainty. I inquired of M. Verschaves' welder if there was not much risk of perforating the tubes by accidental too long exposure to the flame. For reply he allowed just this accident to happen and pierced a hole in the tube. This, by the aid of the iron solder stick, he promptly filled up, building a fresh body forward from the edges of the hole with the greatest ease. The molten steel appears quickly to set, so that this building up is easy to carry out. At any rate he very quickly filled the gap he had purposely burned through. Fig. 5 shows sections of tubes sawed to show the perfect weld.

FIG. 5. SAMPLES OF WELDED TUBES

Welding Boiler Seams

As a steam engineer I am supposed to be very distrustful of welded joints in any part of a steam boiler exposed to internal pressure, but I cannot see any reason why a large acetylene blowpipe should not prove capable of welding stout boiler-shell-plates. There seems to be no possibility of a cold shut; nor need there be any serious objection to leaving the weld slightly full, for there would be no necessity for removing the projecting parts. Also the weld could be made from both sides if this proved necessary to secure a perfect finish. Obviously one would not at once apply such a welded shell to a steam boiler, but the method might well be tested on a shell and tested to destruction by hydraulic pressure. One needs caution at every step in boiler construction, but here is a method of saving large and heavy butt straps, rivets and riveting, which are needed to give joints of even 85 per cent. the solid-plate strength. The acetylene weld offers a probably safe joint free from the dangers of an ordinary weld with its cold shut and imprisoned oxide.

High Temperature of Gases

As regards the high temperature obtained from the flame as compared with that of the oxy-hydrogen flame, there are two especial reasons for this. Acetylene is a gas which, to begin with, is not only wholly combustible but consists almost wholly of carbon. Its formula is C_2H_2, which means that approximately it contains 92½ per cent. of carbon and only 7½ per cent. of hydrogen. Now though the effective calorific power of hydrogen is about 52,300, as compared with 14,647 for carbon, or nearly four times greater, the products of combustion of 1 unit weight of hydrogen weigh 9 units, whereas the products of burned carbon weigh only 3⅔ units, or less than 2½ times the weight of the hydrogen products. This means that the heat generated by the carbon is spread over a less weight of product, and if the specific-heat coefficient of the carbon and of the hydrogen products were the same, the temperature ratios would be $\frac{52{,}300 \times 3\frac{2}{3}}{14{,}647 \times 9} = 1.454$, or the hydrogen flame would be nearly 50 per cent. hotter than the flame of carbon.

But the specific-heat coefficients are not alike. Hydrogen produces steam the specific heat of which is taken ordinarily to be 0.480. At high temperatures it is much higher, but we will assume that it increases at the same rate as does the specific heat of carbon dioxide, which normally is 0.217. This high specific heat of steam gas is a very telling part in the question of temperature production. The above ratio of 1.454 becomes $\frac{1.454 \times 0.217}{0.480}$ 0.66 nearly; or, in brief, hydrogen produces a temperature that is only two-thirds that of carbon. Though acetylene possesses so little hydrogen, yet that small proportion serves to carry a large proportion of carbon in the form of gas, without which conversion it would be difficult to burn carbon as a blowpipe flame. Acetylene is practically gaseous carbon maintained in that state by its chemical union with hydrogen, and, because of its low hydrogen, its flame temperature is very high. This question of flame temperature is interesting, because the high calorific value of hydrogen is apt to lead one casually to think that its flame temperature must be high; for one is apt to overlook the great weight of the products of combustion, and also the very high value of the coefficient of specific heat.

Cause of High Temperatures

The second cause for the high value of the temperature of combustion of acetylene is a physico-chemical one and due to the peculiar conditions incidental to the process of chemical union of carbon and of hydrogen. When some substances unite to form a compound, they generate heat. The union of hydrogen with oxygen and of carbon with oxygen are familiar examples. Other compounds are formed with the reverse action. Heat is absorbed and rendered latent in the act of combination. Acetylene is one of these substances. Such compounds are said to be endothermic, whereas other gases produced with evolution of heat are termed exothermic. Acetylene is endothermic therefore, and it is a curious fact that benzine is also endothermic, though not to the same extent as acetylene. Now the chemical formula for benzine is C_6H_6. Its percentage composition is identical with that of acetylene, C_2H_2, but its molecular arrangement is different.

In benzine we may take it that four carbon atoms are attached on two sides to hydrogen atoms and two other carbon atoms have only a one-side attachment. In acetylene there are two carbon atoms with a one-sided attachment only. It appears as though in some way we might use this hypothesis to explain the endothermic nature of both these compounds as well as the fact that the one with the greater

proportion of singly attached atoms possessed the greater degree of endothermency.

The Chemistry of It

The single attachment of the acetylene molecules may also be put forward to explain why the molecules are so readily detached, that is to say, why acetylene is unstable, easily provoked to explode. The locked-up heat represented by the endothermic property or nature of the gas is set free when the gas is burned, and serves still further to raise the temperature of the flame beyond the intensity of the ordinary method of calculation. We do not, of course, know that such temperatures actually are obtained, because we do not know that at high temperatures combustion is not somewhat delayed. Nor can we afford to overlook the fact that the specific heat of gases rises considerably at high temperatures and keeps down the maximum so called theoretical temperature calculated on the basis of normal specific heat and complete combustion.

Still these facts affect all gases to a greater or less extent, and do not materially affect the practical use of acetylene, the temperature of which is high enough for practical purposes.

As regards the industrial uses of the Fauché blowpipe, these may be many. Small kitchen-range boilers are welded up from outside by light hammer work, and no engineer feels that welds thus made with no anvil support are very reliable affairs. The acetylene weld would be perfect for this class of work. It could be employed to mend locomotive frames in place and to repair cracked cylinders. These are only odd cases which come to mind of its possibilities. For really heavy work it might perhaps have to give place to thermit welding, but for fine, small and medium work there appears to be a very wide field of usefulness in front of it.

Floating Reamer Holder

By E. J. Phillips

Having had considerable trouble reaming holes in steel that would be standard size and smooth, in a Warner & Swasey screw machine that was worn out of line to such an extent that a reamer held in a solid holder would cut a great deal larger than itself, and also grab and tear the hole, I made a floating reamer holder that gives good satisfaction and that will carry a good-sized range of reamer, 1½ inches to 1⅞ inches diameter. I am sending drawings and photos of the holder in hopes that it may lead to criticisms, and also help some who are in the same boat in which I have been. I have several good floaters working on vertical boring mills where the reamer hangs in a vertical position, but putting one on a screw machine in a horizontal position I find another proposition.

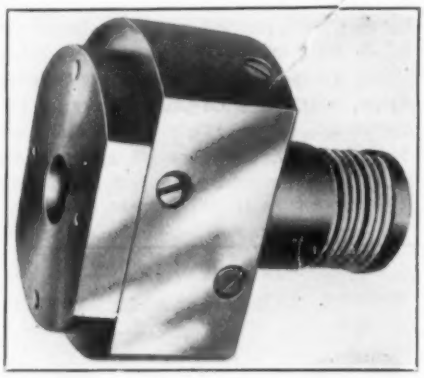


FIG. 1. FLOATING REAMER HOLDER

The Parts of the Reamer Holder

The reamer holder consists of one main body of cast iron, one machine-steel socket or reamer holder proper, two tool-steel rings, hardened and ground in the faces, one brass ring used as a cage for balls, two tool-steel driving pins, four ⅝x⅜-inch headless set-screws, four ⅝x½-inch headless set-screws, eight helical springs, good and stiff, wound so as to be free in a ⅝-inch tap-drill hole, and cut to length required, eight plugs of steel 17/32x⅛ inch, two machine-steel washers, one machine-steel nut, and one helical spring of 3/16-inch wire, and and thirty-two ¼-inch balls.

The Main Body

The main body, of cast iron, has a shank turned to fit the bore in the turret of the screw machine, to which it is fastened by two ⅝-inch cap screws, the same as all other tools on a Warner & Swasey screw machine. There is a 2-inch hole bored and reamed through the casting to allow the socket to pass through, and also to turn it up on. There are eight ⅝-inch tap-drilled holes, four at each end spaced at 90 degrees; the four holes at the rear are 45 degrees out of line with the holes at the front.

The main body is counterbored 3/16

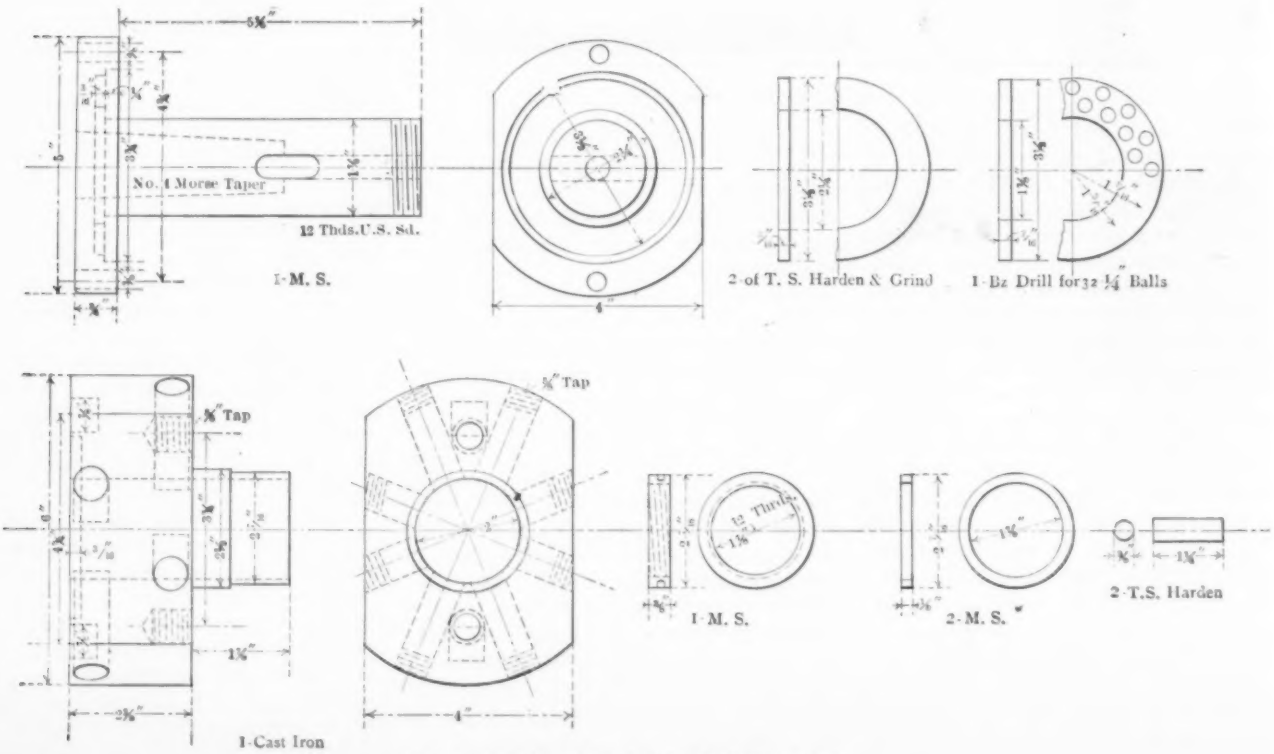


FIG. 2. DETAILS OF FLOATING REAMER HOLDER

inch deep by 3½ inches diameter, to admit one of the hardened rings, which is to be driven in tight. The two square or driving holes are ⅝ inch square by ⅝ inch deep.

The Reamer Socket

The socket is made of machine steel and bored to take a No. 4 Morse taper; it has two ⅜-inch holes drilled and reamed to allow ⅜-inch driving pins to be driven in tight. It is also counterbored 3/16x3½ inches to allow the hardened ring to be driven into it; the ¼x3¾-inch counterbore is made long in diameter for the ball cage; the main shank is ⅞ inch diameter, allowing it to have ⅛-inch clearance in the main body.

Assembling

In assembling, the two hardened and ground steel washers are driven into the counterbores of the socket and main body, and the ball cage is put over the shank of the socket. The shank of the reamer holder is then put through the 2-inch hole in the main body, engaging the driving pins in the square holes in the main body. The steel plugs, springs and headless setscrews are then put in the ⅝-inch tap-drilled holes in the main body, and set up tight enough to hold. One machine-steel washer is then put over the shank of the reamer holder, and rests against the face of the main body shank; the heavy helical spring of 3/16-inch spring wire, 1¾ inches long by 15/16-inch inside diameter, is then put on, washer and nut are now put in and drawn up until the hard rings are in contact with the balls, care being taken that the rear face of the reamer holder and front face of the main body do not rub; about 0.01 inch clearance is what I allowed. The larger the reamer, the more pressure will be required on the balls. It will be seen that the eight springs placed in the holes shown on the drawing hold the reamer central, but still allow it to move up or down or sideways, in fact, in any position parallel with the center line. The square holes cut in the main body do not allow the driving pins to settle in one fixed point, as they would if they were drilled out round.

The ball cage is drilled for thirty-two ¼-inch balls, and the edges of the holes are burnished over to keep the balls from falling out.

I think this style of floating reamer, although a little more expensive than some I have seen described in the American Machinist, is a better floater for use in steel than any other I have ever seen used. It can easily be applied to any turret machine.

Soft solder deteriorates with age. If kept for a long time in a damp atmosphere, the surface corrodes and the metal does not then flow readily.—*The Brass World.*

A Little Story of Education Respectfully Dedicated to Educators

By W. D. Forbes

A young man came into a machine shop and got a job as a lathe hand. He was good at his work and ran his lathe at proper speeds on varicus diameters when the material was considered, and he took big cuts and fine ones in their proper places, earning his sixteen dollars a week.

On Saturday nights he with many of his shop mates took in a vaudeville show and contentment, to a very large degree, was his lot. Every now and then he had to cut threads and he would look at a little brass plate on the headstock of his lathe and it would tell him what gears he had to put on the stud and on the screw, and there was no trouble at all in getting the right thread.

He often heard about the "angles of threads," their "pitch," "the area" of a piston and the "tensile strength" of steel and iron and other metals, of "plans" and "elevation," but just what they all meant was not clear to him.

One day the foreman gave him a job which required 11½ threads to the inch and his little plate failed him. He told the foreman that his lathe would not cut 11½ threads. The foreman asked why it would not? He did not know. He thought he remembered that a lathe he had seen did cut 11½ threads.

The foreman looked at the little plate, figured a half minute and told him to use certain gears and to his great surprise the job came out all right, and to him the foreman became a great mathematician.

Some time later again the little plate failed and the foreman was out looking after a break-down job. Here was real trouble. The work was wanted at once and he could not do it. An apprentice boy who had helped him now and then in taking off his chuck and putting long pieces between centers, asked what was the trouble and was told. In a few minutes the proper gears had been figured out by the apprentice and with fear and trembling used, and "mortification" set in when the job came out all right.

A few nights later the lathe hand was at an evening school with the apprentice awkwardly working over a drawing board. In six months he had mastered the mysteries of "plans" and "elevation" and "assembled drawings" and what had been so hard before to understand in blue prints was now clear, and the words "angles" and "areas" conveyed real meaning to him. He could figure out just how many feet the surface of a shaft was making in a minute and what size piston rod should be used for a given area of piston with a given steam pressure, and he could cut any thread wanted without ever looking at the little brass plate.

He was so carried away by the desire for knowledge that he began to feel very sorry for the rest of his fellow workmen and he induced many to go to night school.

One day he asked the foreman for a raise in wages and got it the next week. This acted like a spur to a horse and the value of education and knowledge was practically proved. He talked education at noon to his shop mates and before he knew it he was shouting its value like a campaign orator. He besought all to study, learn, and thereby rise to higher planes so that they could all become foremen and proprietors.

Soon he was made foreman of a room, he never went to vaudeville shows but took in all educational lectures and he continued to extol the value of education. He did not, however, find being a foreman as easy a job as he thought it was and he began to understand why a foreman was so anxious to get the work out quickly and swore so when the job was spoiled or delayed.

One thing troubled him, however, a good deal and that was the fact of not being any happier than he was before he gained knowledge—the ability to figure out threads and areas, and to know what π stood for. To be able to figure threads and almost everything else was nice but he worried a good deal because he could not tell the difference between an involute and an epicycloidal form of tooth and more because so many jobs were spoiled by the men and that was something he never did before he was a foreman.

He still talked education to his men. One day while doing so at noon he pointed out of the window to two men digging a ditch in the street and said, "Knowledge is what you want. Look at those two men at work in the street at a dollar and a half a day. With knowledge they could lift themselves above such work and earn twice as much! Mike, the oiler who sat by his side smoking his clay pipe, looked up and said, "If we all got education who would dig the ditches"?

An important step in the substitution of steel for wood in the construction of railroad passenger cars has been taken by the Pennsylvania Railroad, which has ordered 200 such cars from designs worked out by its own engineers. The equipment comprises coaches, baggage, mail and dining cars and is by far the largest yet given for main-line equipment of this character. The passenger cars will contain but 300 pounds of wood. Arrangements have also been made with the Pullman Company to design and build sleeping and parlor cars of steel. In general arrangement and appearance the new steel cars will closely resemble the standard cars of wood. Complete working drawings of them are published by our contemporary, *Engineering News*, from which article the above facts are taken.

The Bonvillain and Ronceray Universal System of Machine Molding at Philadelphia

The Bonvillain and Ronceray molding machinery, about which we have published several articles, was represented at the recent American Foundrymen's Association convention in Philadelphia by an excellent exhibit, which attracted much attention and at which were found some new points of interest.

A Combination Controlling Valve

Instead of the drawing of the pattern being accomplished by the operation of a lever placed in front of the machine acting on a valve placed inside of the machine, a new combination valve, shown in Fig. 1, has been designed and placed outside of the machine, where all parts are easily accessible for inspection and repair, with the object of collecting and controlling the pressure water and exhaust water from all the cylinders of the machine, acting as a stop valve for cutting the whole machine off from the line for repairs, and acting as an admission and exhaust valve for the pattern-drawing arrangement. By means of the small screw shown on the left, the speed of the pattern-drawing arrangement may be regulated, enabling the operator to draw difficult patterns slowly and carefully, and on plain work to go ahead at full speed. The pattern-drawing valve is worked through a cam mounted on a shaft on which is keyed, in addition to the lever in front of the machine, a pedal shown at the right of Fig. 1. A spring pulls on this pedal so that, when free, the cam puts the pattern-drawing cylinder to exhaust.

When set for general work, as soon as the man presses on the pedal, the drawing table is lifted; as soon as the operator leaves the pedal free, the table falls down to its original position, leaving the pattern plate and machine ready for another mold. But by setting a small screw placed on the lever in front of the machine the lever is allowed to go a little further when pressing the pedal, and it then engages in a lock stop, so that when the pedal is abandoned, the drawing table does not fall down until the lock is released. Packing pieces can be placed under the flask to support it level and a perfect draw is made on difficult stripping-plate work when the lock is released. Quickness and accuracy of drawing and the performance of every motion at exactly the right instant are considerations aimed at in this arrangement.

The old lever in front of the machine has been retained to allow the use of the double ramming device, but it is not used for pattern drawing; this work is entirely accomplished through the pedal which is on the back of the larger machines, where two men are required to lift the flasks, and on the front for the smaller machines, from which the flasks can be removed by one man.

A New Small-size Hydraulic Machine

For small foundries where it was not desired to make a hydraulic installation the manufacturers have been supplying a small molding machine (No. V-4) on the same general principles as the hydraulic machine (originally described at page 718, Vol. 28, 1905, Part 2), but with the ramming done by hand power applied to a fly-wheel on the top of a screw, and the drawing of the pattern accomplished by foot power applied to a pedal. This sized machine, however, became so popular in large foundries that a hydraulic machine of similar size has been brought out. This machine, No. A-6, which is shown in Fig. 2, is a little larger than the screw ramming machine, taking flasks up to 14x14

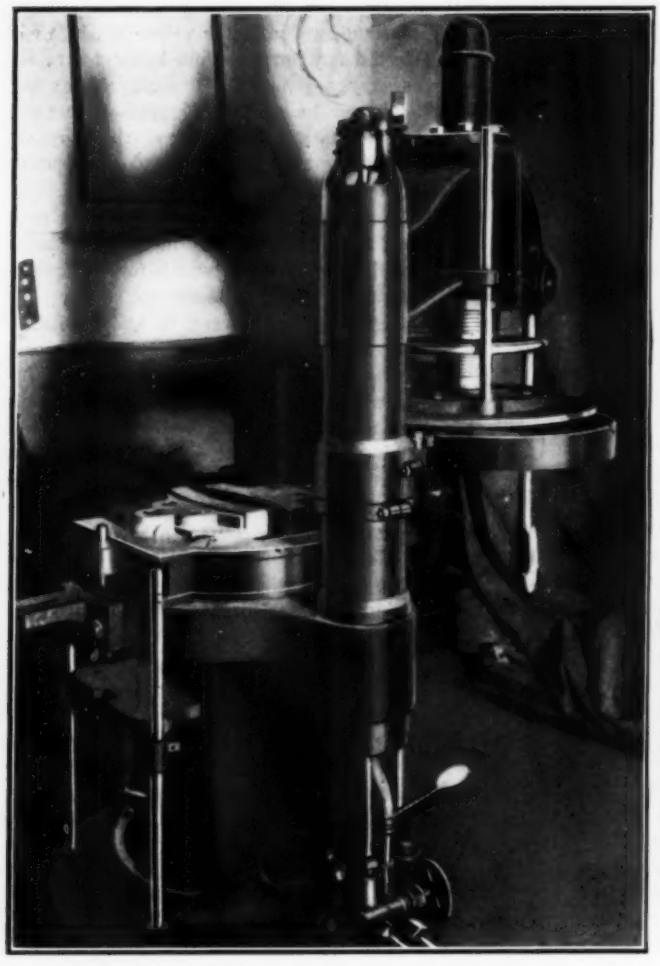


FIG. 1. SHOWING THE NEW COMBINATION CONTROLLING VALVE

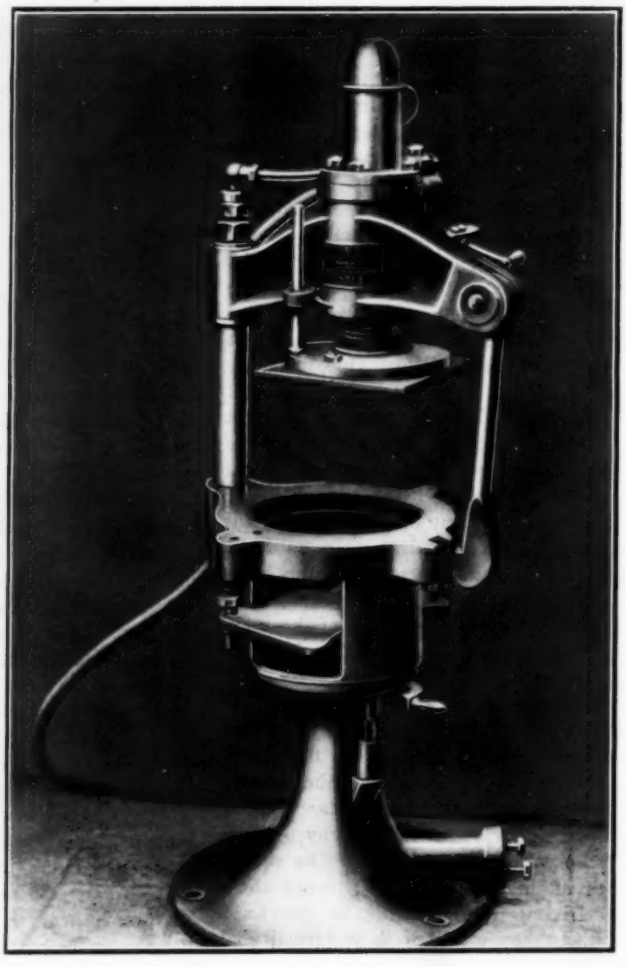


FIG. 2. NEW SMALL HYDRAULIC MOLDING MACHINE, NO. A-6

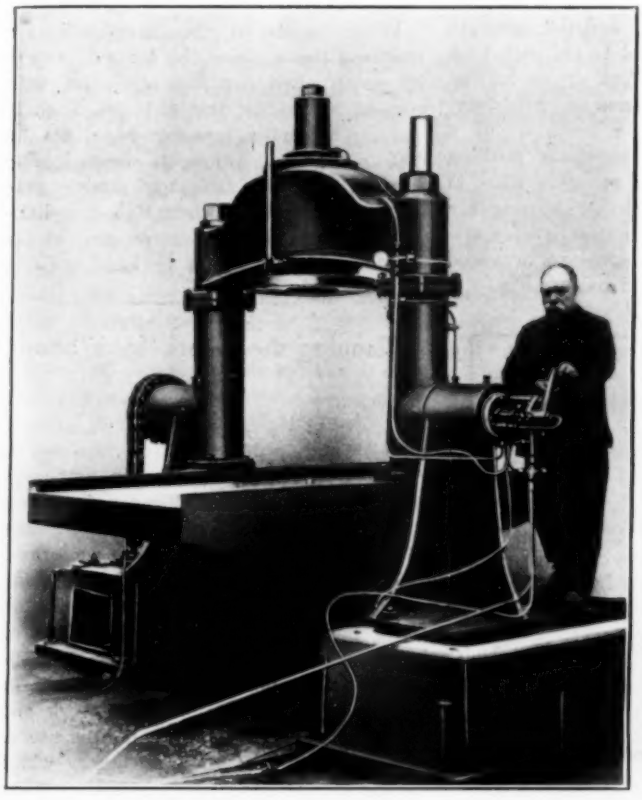


FIG. 3. LARGE ROTATIVE MOLDING MACHINE, TYPE RM3

FIG. 4. RM3 MACHINE BEING TURNED OVER

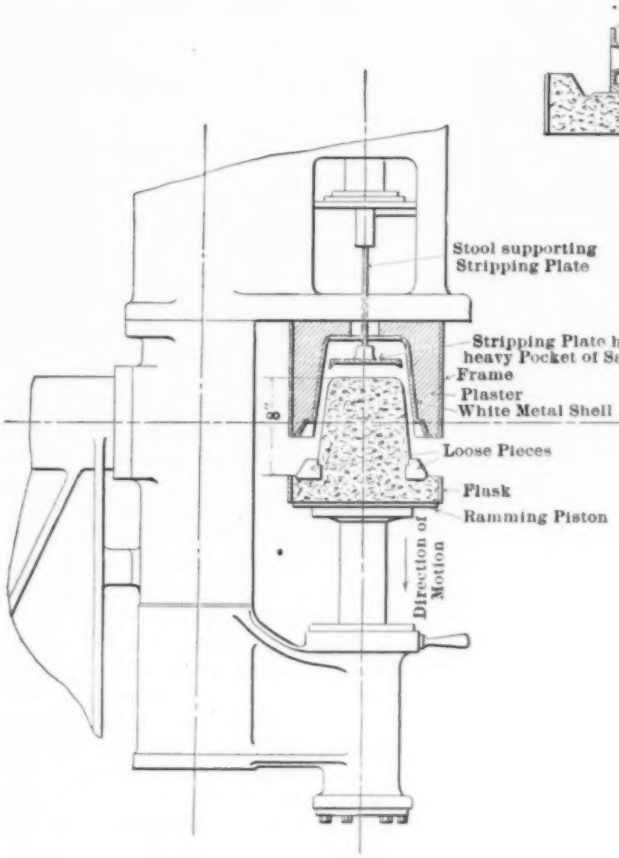


FIG. 5. ROTATIVE MOLDING MACHINE, TYPE R-4, MOUNTED FOR MOLDING FLUSHING TANKS

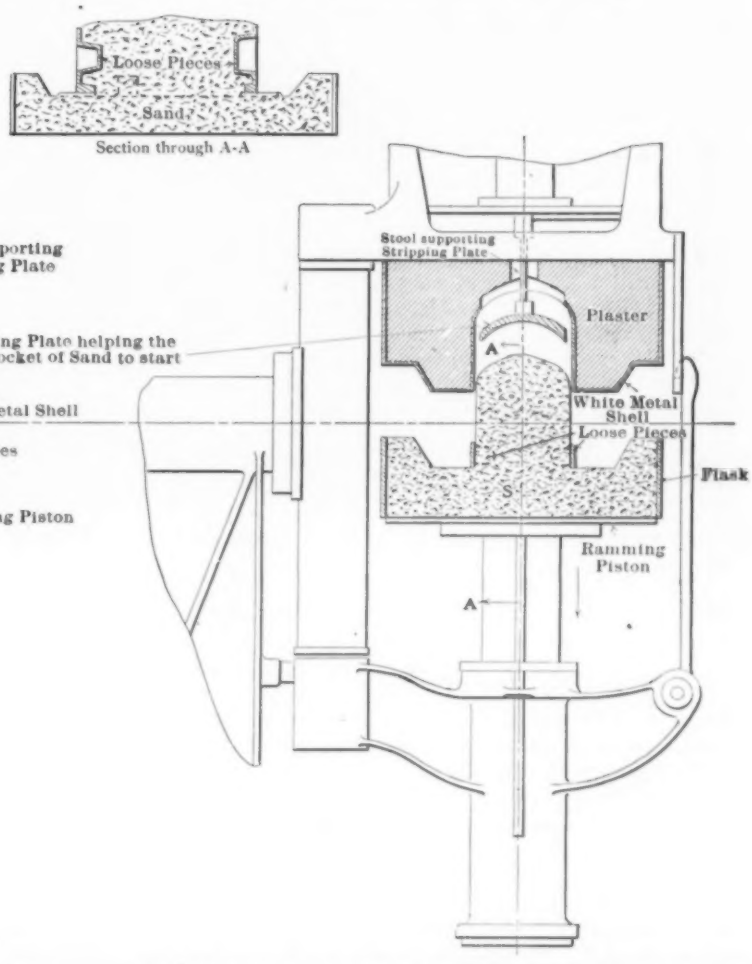


FIG. 6. ROTATIVE MOLDING MACHINE, TYPE R-3, MOUNTED FOR MOLDING AUTOMOBILE GEAR CASES

inches instead of 10¼x10¼ inches. The illustration shows the extension ear arranged for taking the larger flasks.

A Large Molding Machine

The machine shown in Figs. 3 and 4 is interesting on account of its large size. It is a rotative molding machine which was made for a large English concern making cotton machinery, and on it are made card sides 3 ft. 6 in. by 10 ft. In Fig. 3 the machine is shown in its normal position, and in Fig. 4 it is in the process of being turned over.

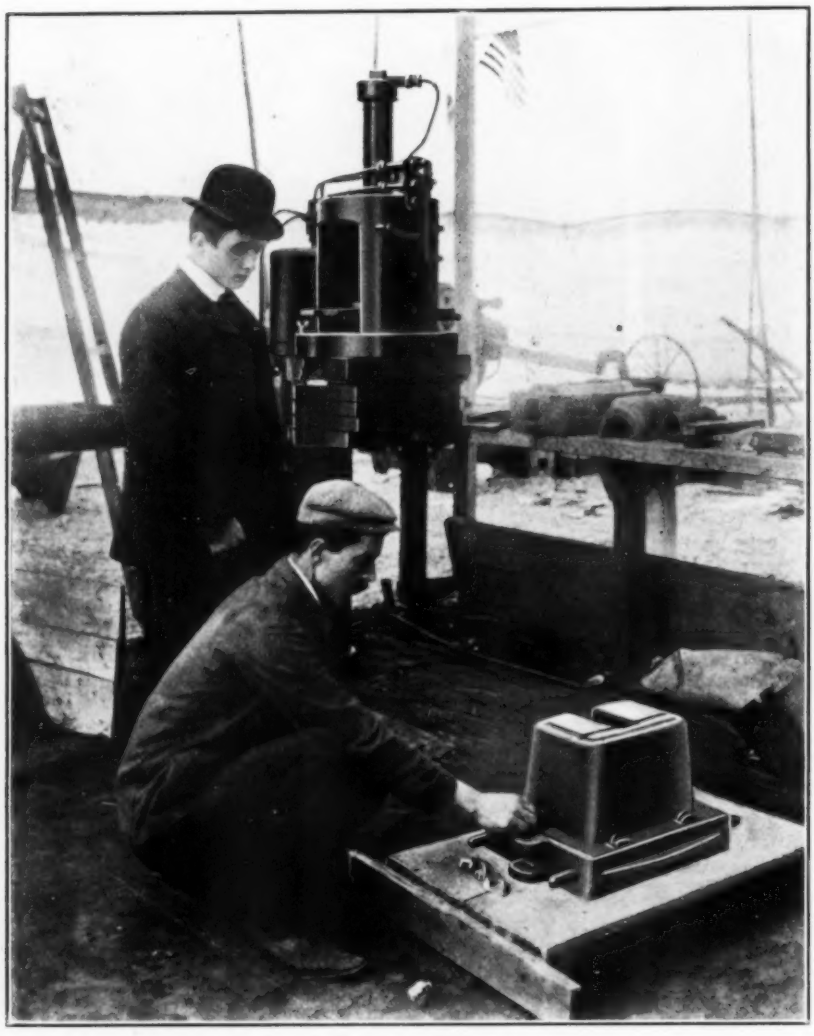


FIG. 7. COMPLETION OF THE NOWEL MOLD SHOWN IN FIG. 3; LOOSE PIECES BEING REMOVED

The Rotative Molding Machine

An opportunity was, at the exhibit, afforded of seeing in operation the rotative molding machine, of which a quite complete description was given at page 236, Vol. 29, (1906) Part 2. The accompanying sketches give a very clear idea of the way in which these machines handle molds with deep cores. It will be recalled that, after ramming, the whole machine is turned 180 degrees around a horizontal axis, so that the mold rests upon the ramming plunger; upon pressure being admitted to the stripping cylinder (now uppermost) and the ramming cylinder being connected to exhaust, both plungers go downward, as shown in Fig. 5, the work here illustrated being the making on an R-4 rotative machine, of a nowel mold for a water-closet flushing tank; the action of the stripping plate at the bottom of the tank in assisting the heavy pocket of sand to start is very evident. There are six loose pieces arranged to make inside projections; in Fig. 7 a nowel may be seen removed from the machine and set on the board, with the operator taking off the loose pieces, three of which, already removed, may be seen on the board beside the flask.

In Fig. 6 a partial section is shown of an R-3 machine, which was engaged on making nowel molds for automobile aluminum castings. Here also is a bottom stripping plate, curved in this case, and there are four loose pieces, better shown in the small sectional sketch. This mold was about 23x32 inches and weighed about 500 pounds. The flask was removed by means of a Moyer tram-rail without swinging open the head of the machine.

Machine Reversed by Power

When molds of this magnitude are made on the machine the latter is swung by power, two hydraulic cylinders with pistons acting on the ends of a chain passing around a sprocket wheel on the hub of the swing frame, as shown in Fig. 3 (page 236) of the 1906 article previously referred to, though in the halftones in that article the swinging of the machine is shown done by hand.

Planning the Work in a Shop

By S. H. Bunnell

It was F. W. Taylor who first suggested that the shop foreman has been loaded with a multitude of miscellaneous duties, most of which should be performed by other men. In the small shop which was once the rule, the foreman worked with but few drawings and no lists of parts, and had under him a force of competent all-around machinists, each of whom could lay out his own work and produce the necessary parts by the use of any or all of the shop machinery which might be required.

The growth of the machinery business has been accompanied by an apparent decrease in the number of skilled machinists able to run several different tools if required, or at least the ratio of such men to the shops of the country is much diminished. To supplement the force of competent men now employed in a large shop there are a great number of second-class machinists, handy men or helpers, as they are variously called, and the work is so divided and arranged that the greater part of the work done by machine tools is allotted to men each of whom is skilled in the use of one tool, and frequently is able to perform only a single operation or a class of operations. In most cases the duties of the foreman have not been correspondingly simplified; in fact, they have been considerably increased.

Foreman's List of Material

It is now the rule in all but the smaller shops to furnish the foreman with a complete list of parts of each machine which is to be constructed, accompanied by drawings of each of these parts. To this extent the work of the foreman is assisted, as he is no longer obliged to carry in his head the entire detail of the parts required, and, as was often the case, many of the dimensions for these parts. It is still the rule, however, to stop here in the subdivision of the foreman's work, leaving him to plan which parts are first required, which tools shall do the work on each part, what style of cutting points and what speeds and feeds can be employed, how the work shall be attached to the machine, carried from one to the other, and laid out before machining, and

finally to inspect the finished pieces to determine their accuracy.

All this detail is so commonly carried on by machine-shop foremen that the suggestion that a simplification of each man's work and its subdivision among several men would result in greater efficiency of each, and in a net saving to the shop, was at first received as startling. It has been shown, however, by the actual introduction of planning systems, that cost may be reduced, deliveries hastened, and satisfaction generally increased.

Showing the Value of a System

Perhaps the best way to demonstrate the value of a planning system is to start one and operate it for a short time. Evidently the sales department should not promise work without reference to the possibility of constructing it during the time limit set. This is usually done by a simple 'guess, based on the approximate value of the shop output per month and the apparent number of months' work ahead on the books; or by a mere estimate by superintendent or foreman, made without any real basis other than a guess.

In this way it may be discovered that work which apparently is of small value and should come out easily within the promised time involves the use of a single machine, or the making of a certain class of castings, the product of which is already sold out for a considerable period. The same thing often occurs in a stock room, where an apparent large stock of a certain part is suddenly converted into a deficiency by the receipt of requisitions for more parts than are on hand and failure to anticipate this condition, though orders on hand calling for these parts have remained unfilled.

Work of the Planning Department

The planning department takes in hand the bill of material for each order as entered, ascertains what parts, if any, are in stock, and makes up a schedule, counting back from the time of delivery if one is set, so as to ascertain the number of days required to paint and box the machinery, and the date on which this work should begin; the number of days for assembling and the date this should begin; and the number of days previous to the requirement of each part on the assembling floor that the work on this part should begin, and so on back to the date of delivery of each part in the form of raw material.

With this information at hand, it is at once evident whether the time of delivery cannot be kept, by reason of the impossibility of furnishing some part on time to fit into the scheme. The information so obtained can be used and sent to the shop in any of several ways. It may be in the form of daily orders, each one calling for the delivery of a part, or the performance of a certain operation on a certain date; or schedules may be made showing the required date of commencement of all steam cylinders, for instance, and of all frames, and so on. Evidently drawings for these parts must be ready in advance of the work on each part. In short, instead of the foremen merely guessing when the different jobs should be finished, each man may have in front of him each day a sheet telling him exactly what pieces and what operations should commence on that particular day.

Reducing Foremen's Headwork

This all sounds very complicated, but is precisely what the foreman is at present attempting to do unassisted. It is no wonder that under the pressure of extra haste, and with a large volume of orders ahead, the shop work should go more slowly than ever, and the quantity of unfinished material in the works should increase beyond all proportion to the amount of orders on the books. The man who reduces the foreman's headwork to written schedules in this way will have a very much increased respect for the ability of the foreman who has been doing this work aside from his proper duties of directing the mechanical operations.

Each schedule once made is ready for use every time a similar machine is ordered and placed in the works. Careful attention to the making of such schedules will result in the accumulation of information which will later take care of itself, and enable work to be planned without thought other than to copy off schedules previously used. The impulse of the busy foreman to expedite his own work by taking up the first thing at hand or in sight can be in this way very much controlled, and his daily sheet serves as a daily reminder of parts likely to be forgotten.

How the Schedules Work Out

In the practical use of these schedules of work, stock on hand is easily taken care of, and necessary stock parts provided for by simply counting back from the date at which parts are required and entering the proper order for such parts a sufficient number of days in advance If more elaborate planning is carried on, so that instruction cards are furnished to the men directing the method of machining each piece, these cards are provided in accordance with the schedule a sufficient number of days ahead.

In the end the records may be all turned over to a careful clerk of moderate ability, and by following up the daily sheets to be sure that work is done according to the plan, the various pieces will fit in together exactly as required, and there will be very much less labor cost unnecessarily tied up in pieces that are not wanted for many days.

The man in charge of the planning system, being practically very close to the foreman and the shop force, can readily arrange to avoid instructing the commencement of more than one piece of work on a single tool at the same time, and alter his schedules where required to anticipate such conflicts, delivering some parts if necessary earlier than required for assembling, so as to relieve congestion at the machine.

Helps the Foreman Turn Out More Work

It will be found that the entire attention of a man to this detail of the foreman's work will result in very great improvement in the results produced by the shop.

The schedule shown is supposed to represent the order of work on a small steam engine built singly, and is not complete as to all the operations, but fairly illustrative of the method. The first casting wanted is the cylinder, on June 7; hence patterns must be ready June 4, and drawings, June 3. The connecting-rod is supposed to come from a stock order, S-343, which would be scheduled separately and traced up so as to have one rod at least ready on June 20. On the 22d the engine is put together ready for adjustment, and thereafter the whole is treated as a single unit.

SCHEDULE OF WORK FOR 10 x 10 HORIZONTAL ENGINE.

Part.	Ship. July 1.	June 27	26	25	24	22	21	20	19	18	17	15	14	13	12	11	10	8	7	6	5	4
Cylinder	Box—load & ship.			Paint.		Adjust and test.				Attach		Fit	Sc.	Stud	Dr.	Pl.		Bor.	×	Mold.		Pat.
Head													Dr.	La.	×							
Gland													Dr.	La.	×							
Cover													Dr.	Pl.	×							
Valve													Sc.	Pl.	×							
Stem							La.	For.	×													
Piston							La.		×													
Rings							Fit. × -finished, from stock															
Rod							La.		×													
Crosshead							Fit.	Mill	La. Plu	La.	Pl.	×										
Frame									Bab.	Dr.	Pl.	Bor.	Dr.	Pl.	×							
Caps													Dr.	Pl.	×							
Guides							Fit.		Pl.	×												
Shaft								Fit.	La.			K.S.	Slot	Dr.	×							
Wheel							Fit.	Pol.	Bor.	M.	×											
Con. Rod							Fit. × -deliver finished, from stock order S-343															

Symbols:
× = Deliver rough material. La. = Lathe work. K.S. = Keyseat. Sc. = Scrape surfaces
Pl. = Planer work. Dr. = Drill.

Improvements on Compressive Riveters

Illustrating the Advances That Have Been Made in Riveters for Concrete Mixers and a New Type of Boiler Riveter

BY CHESTER B. ALBREE*

In compressive-riveter work there are two or three types which are quite familiar, the oldest type being the straight hydraulic machine invented by Tweddel, in England, and later on, the pneumatic riveter by Allen, of New York, who was perhaps the first to make it a success. Later came the hydro-pneumatic riveters. With the hydro-pneumatic riveter we have been making some experiments, and it was found to be advisable for several reasons, notably for greater economy of air, simplicity of construction and better action; to try to improve the methods that had been in use. In driving rivets the pressure required differs from punching materials in that in punching, your greatest pressure comes at the first of the stroke, when the punch comes down on the material. In riveting, however, especially hot riveting, the easiest work is when the die first strikes the rivet and the greatest pressure is required to finally form the head. That being the case it can readily be perceived that a constantly increasing pressure would be the theoretically correct pressure to drive rivets. This pressure is most easily obtained by means of the toggle joint, which theoretically gives an infinite pressure with an infinitesimal movement at the end of the stroke In practice, of course, we do not get an infinite pressure; but, as most riveters are of horseshoe or yoke type, the limit pressure is the yielding point or the bending point in the yoke. In straight toggle-joint machines the general idea is shown in Fig. 1.

In practice we find that when the cylinder has made seven-eighths of its stroke the pressure line of the rivet dies rises up to about 15 times the pressure in the cylinder. By that time we would have traveled within about 1/16 inch of the final stroke of the machine, and beyond that point the probabilities are that there would be spring in the yoke. If we made the yoke strong enough not to spring at all, it would be so heavy as to be utterly unmanageable. So it is only necessary that deflection should not occur at a pressure below that necessary to drive the rivet. Hence in the toggle-joint arrangement we have the best possible arrangement for driving rivets.

But there are certain drawbacks in the practical application of the toggle pressure. The principal one is that its stroke is absolutely fixed. It never varies for a given leverage. In riveting you are liable to have 1 inch or 2 inches, or maybe only ½-inch thickness of plate, and in order to have the maximum pressure just as the die comes to the surface of the plate it is necessary to adjust the distance between the die and the point of maximum pressure by means of a screw actuated by hand. In work that does not vary it makes little difference, but in ordinary structural work, and boiler work, you have constantly to drive rivets through different thicknesses of material, and each time it will be necessary for the operator to adjust the screw. That requires a certain amount of skill, and if it is not done correctly the chances are that you will not drive the rivet sufficiently tight, if you do not close it with maximum pressure.

To overcome this difficulty of adjustment the hydro-pneumatic machine was devised, which is nothing more nor less than a hydraulic intensifier. The ram alone gives a very small but powerful motion, and it is necessary in riveting to have clearances, in order to go over angles, stiffeners, etc., so it is desirable to have a longer stroke. Of course, we do not need high pressure over a longer distance than, say 1¼ inches. The question then was how to get a clearance movement. This was accomplished by putting a little extra cylinder below the air cylinder. The air pressure acting on its piston forces liquid into the ram cylinder at low pressure, and by this means we get 3 or 4 inches of preliminary adjustment.

The objections to this form are in the first place: that it is very difficult to pack, and second, that in order to get two inches of die motion with a maximum pressure of 50 tons, it requires a 15- to 20-inch stroke in the air cylinder, and a very high pressure throughout this stroke in the ram cylinder and plunger cylinder: sufficient for the final closing pressure, thus wasting power. The practical advantage is that it does not require skilled workmen to adjust the dies; they adjust themselves. It occurred to us that we might get the desired toggle-joint effect and yet have an automatic adjustment,

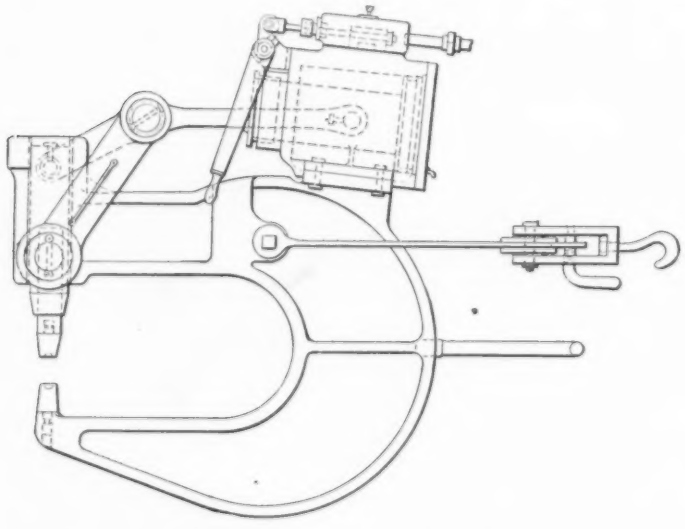


FIG. 1. GENERAL ARRANGEMENT OF RIVETER

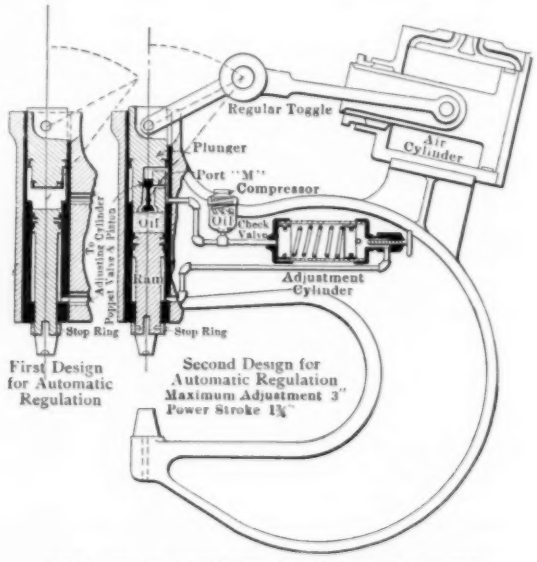


FIG 2. FIRST ATTEMPT AND PERFECTED DESIGN

*President Chester B. Albree Iron Works, Pittsburg, Penn. Proceedings of the Engineers' Society of Western Pennsylvania, May, 1907.

and what I want to speak of is the device for the accomplishment of this, which may be of interest to you.

In Fig. 2 is shown our first attempt and also our perfected form. As far as the toggle-joint action goes it is practically the same as the first machine described. The pressure from the toggle, in the first form machine, is transmitted from the large area of the plunger to the top of the ram, and also through a pipe to the adjusting cylinder. The ram being smaller in area and free to move, advances more rapidly than the plunger and continues until the rivet die on its extension strikes the projecting rivet. As the plunger continues, the pressure in the cylinder is limited by the pressure due to the spring in the adjusting cylinder, which is only 20 pounds per square inch, insufficient to upset the rivet beneath the ram. Hence the liquid will now displace the piston in the adjusting cylinder, the ram remaining stationary. As soon, however, as the projection on the plunger enters the ram cylinder the full toggle pressure is transmitted through the incompressible liquid to the ram, forcing down the rivet, and the differential area above forces the remaining liquid in larger plunger bore into the adjusting cylinder.

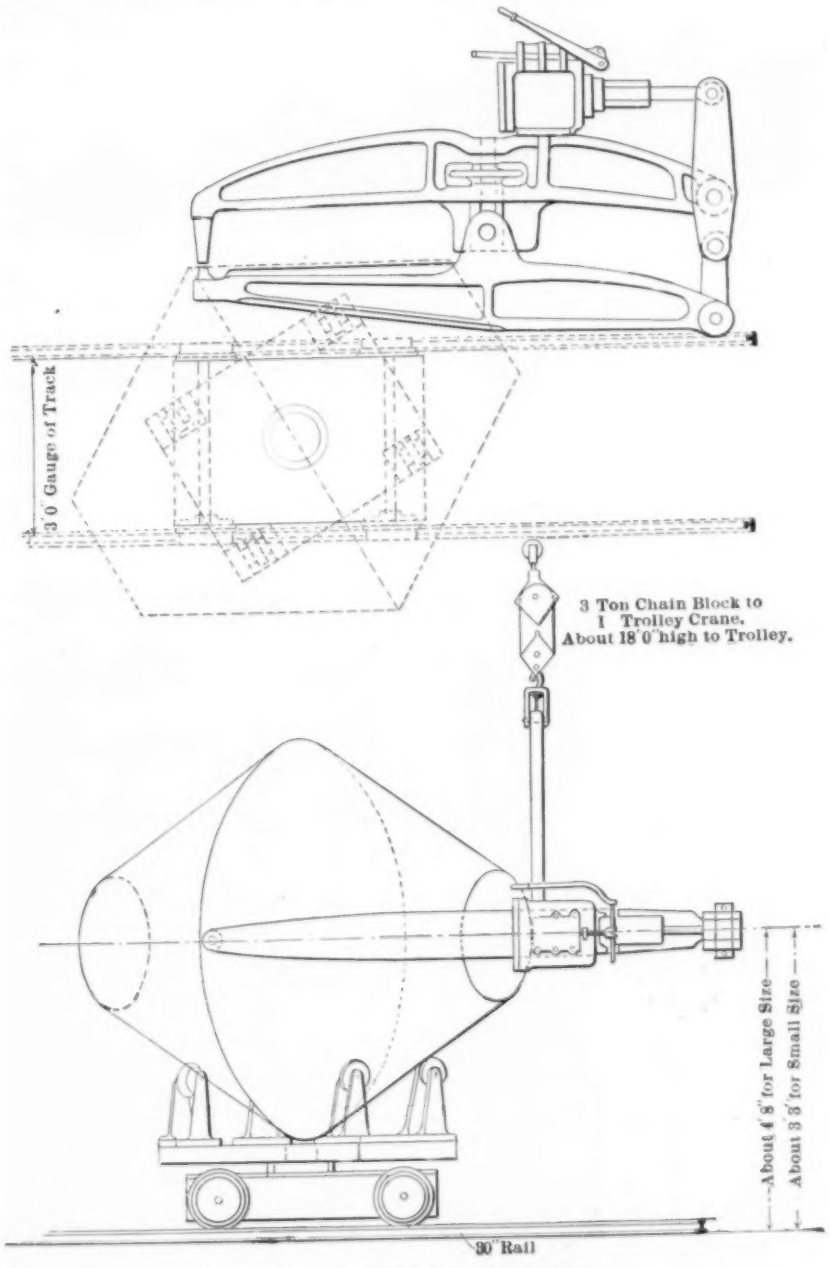

3'0 Gauge of Track
3 Ton Chain Block to
I Trolley Crane.
About 18'0 high to Trolley.
About 4'8" for Large Size
About 3'3" for Small Size
30" Rail

FIG. 3. RIVETING CONCRETE MIXERS

During the downward motion of the ram the liquid beneath it is forced into the opposite end of the adjusting cylinder, against the spring pressure. It is obvious that the ram may move its whole adjusting stroke, or none at all, up to the time that the projection on the plunger enters the smaller area, after which the further travel of the ram is that of the plunger, until the ram meets opposition greater than the pressure of the toggle, when it will stop. This arrangement, therefore, automatically adjusts the point of maximum pressure to suit the work. On the return stroke we have the direct pressure beneath the ram, as well as the suction of the plunger, to raise the ram to its original position.

Theoretically this design was correct, and it worked very well indeed for about two strokes. At the end of the second or third stroke our packing was gone and we have found it impossible to hold the pressures. The trouble lay in the fact that we put cup leathers at the end of the plunger, and when the cup leathers entered the chamber, the moment the pressure rose to a high point it tended to cut the leather right out. So in order to make the device practically, as well as theoretically successful, it was necessary to devise some scheme to have the leather cups, which hold better than any other hydraulic packing, move always surrounded by the walls of the cylinders, and pass no ports whatever. To do this and yet allow the liquid to pass freely from the upper to the lower part was rather a difficult proposition. We accomplished it in this manner.

Referring to the later form in Fig. 2 it will be noted that the extension of the plunger, when full up, projects into the smaller area of the ram cylinder; and that cup leathers are used to pack it. In the interior of this extension is a valve of the poppet type, but having a stem carrying on its end a small piston. This valve is normally held open by a spring. So long as the pressure above and below this small piston is the same, the spring holds the valve open, but when the pressure below is greater than above the piston will move up, closing the poppet valve. This occurs only when the port *M* leading into the space below the small piston is closed; due to its passing from the large diameter bore to the smaller ram bore. When closed, the toggle pressure acts on the liquid below the plunger extension, raising the pressure sufficiently to move the small piston and connected valve; and later exerting very high pressure on the poppet valve; shutting it perfectly tight. The adjusting action is precisely the same as in the first type, except that the liquid flows through the plunger extension instead of around it, during the adjustment part of the stroke. With this arrangement it will be noticed that all of the plunger and ram packings are continually enclosed by cylinder walls and pass no ports or openings, so that the packing leathers are not injured. I would say that the adjusting device is patented and the poppet valve device is now being patented.

In any device of this kind there is always a certain loss of liquid due to a film in the ram (although theoretically the quantity of liquid is constant) and in the course of a little while there would be a partial vacuum inside and pressure on a

cavity would not give good hydraulic pressure on the rivet. It was therefore necessary to provide a constant source of supply of the liquid, so arranged that when the pressure rose in the confined liquid it would not blow out, but when there was a vacuum in the system additional liquid would run in.

This loss of liquid is made up from a small storage, or compensating cylinder, full of liquid; having a piston with a spring behind it, connected to the larger bore of the plunger by a pipe, having a check valve in it. Whenever there is pressure in the plunger cylinder the check valve remains closed; but when the toggle is fully back, and the piston in the adjusting cylinder is against its cylinder head, so that no pressure due to its spring is exerted on the liquid, any loss of liquid will tend to create a vacuum in the plunger cylinder, and then the check valve will open and oil flow out of the compensating cylinder, under the pressure of the spring acting in its piston, to replace that lost.

Pneumatic Hammers

There is one other little thing I thought I would speak of. We have been working on pneumatic hammers and we have now perfected a hammer and there are one or two features about it which are novel and I think you will be interested in. In pneumatic hammers of nearly all makes, one of the sources of trouble has been that if the workman picked up the hammer and put his finger on the trigger when there was no chisel or rivet set in it, the piston would begin to reciprocate, not having any tool to strike at the lower end it would strike the cylinder head; and in a matter of a minute or two it would smash the piston or cylinder. About 75 or 80 per cent. of the breakages of pneumatic hammers are due to carelessness of the workmen in pressing on the trigger when there is no work to do. In other words the little piston strikes the cylinder head with very disastrous results. We have devised a method of obviating this trouble that is very simple.

The admission port is located near, but not at the end, of the larger cylinder bore. When no tool is placed in the end of the hammer, the lower end of the large piston diameter passes and closes the admission port, thus preventing air from acting upon the differential area to lift the piston. Any compressed air below the large diameter escapes by a small leakage port to the exhaust, and this leakage port is only open when the admission port is closed. In hammers actuated by valves exterior to the piston it seems impossible to use this device, and attempts have been made to mechanically close such valves, but they do not appear to be very successful. The same effect is obtained, but at the expense of loss of air, when the leakage port is designed to open when the piston is at the extreme end of the stroke, but does not close the admission port. Patents are now pending for these improvements.

This very simple device is very effective. We can pick up a tool and with 100 pounds air pressure in the pipe, put your finger on the button opening the throttle, and it does not start unless the tool is fully in place, whereas with all other tools that I know of the moment you put your finger on the trigger it begins to work, and it is only a question of a few minutes until it is good for nothing.

A Special Riveter

I might speak of another machine that has a feature of interest that was built for some special work. The work to be done was the riveting of some concrete mixers, they being in the shape of two cones placed together. The problem was to reach into a very limited space and drive the rivets. They had been doing it by hand and wanted something a little quicker than the pneumatic hammer, and something that gave tighter rivets, and wanted a power machine. It was necessary to have a reach of some 50 inches, and we had an extremely small opening. At the same time it was necessary to be able to adjust for different thicknesses of material, and to give what we call an alligator motion to the jaws of the machine. The

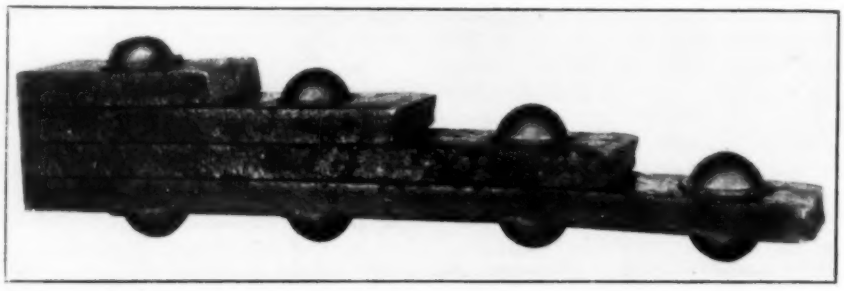


FIG. 5. SHOWING RIVETS DRIVEN THROUGH DIFFERENT THICKNESSES WITHOUT ADJUSTMENT

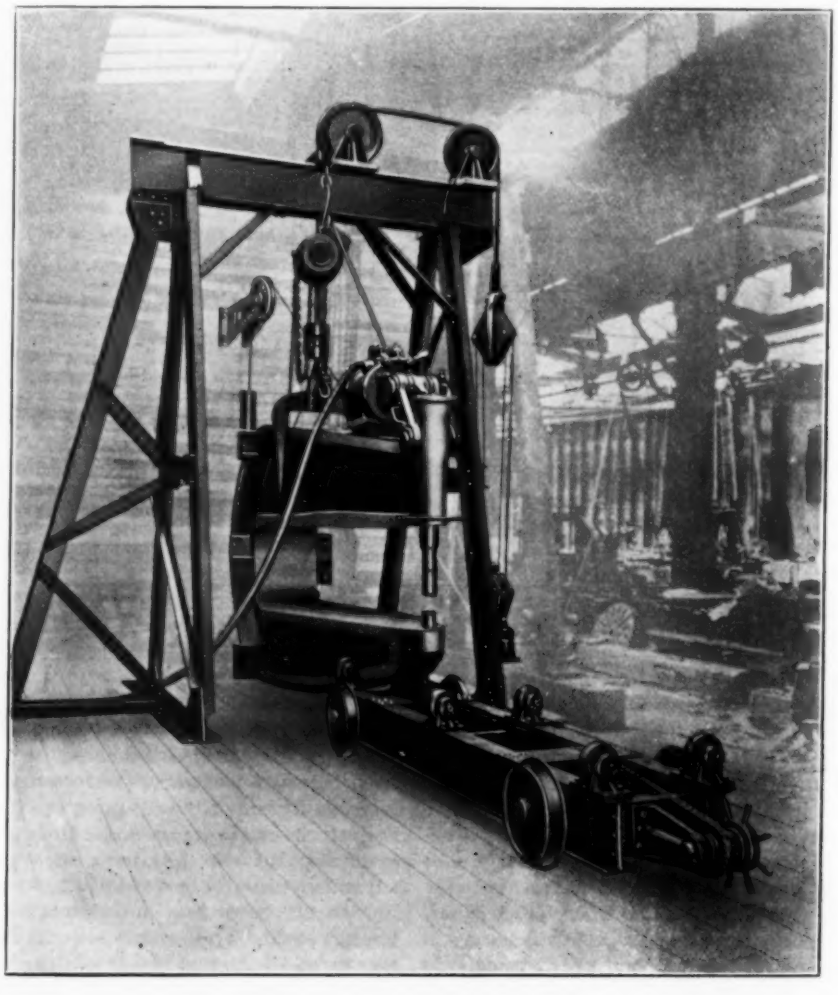


FIG. 4. RIVETING ARRANGEMENT FOR BOILERS

ordinary riveter could not be used for this work.

To secure adjustment of the projecting alligator jaws of the machine we inserted a screw carrying the trunnions of the fulcrum on one end—a hand wheel, with thread in the hub, serves to raise or lower the screw—thus adjusting the distance between the ends of the jaws as desired, and at the same time not interfering with their clearance or action.

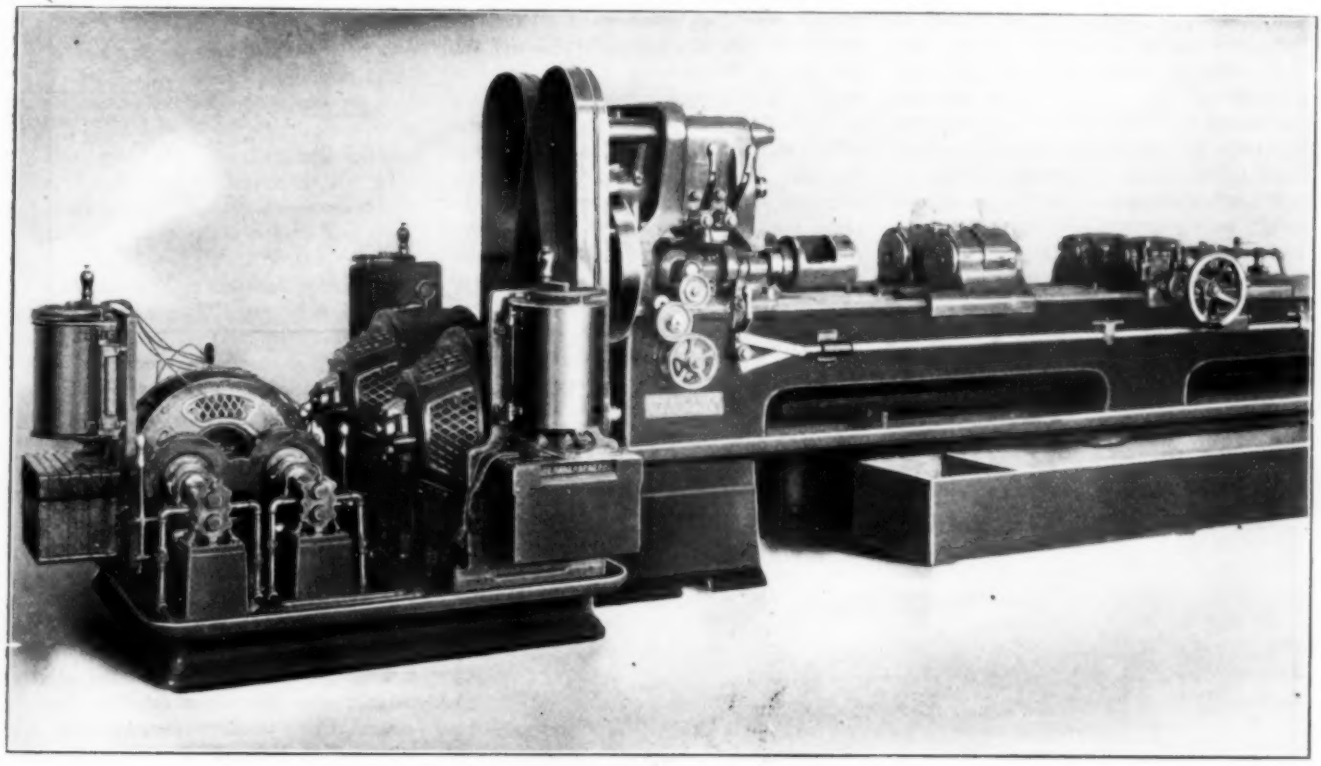
The details of the machine are plainly indicated in Fig. 3—it is provided with a universal bail, so that it can be used in any plane at any angle.

We also designed a special carriage to hold the double cones, rendering it unnecessary to raise either riveter or cones, but only to revolve the cones on their axis. We also have a new way of riveting boilers, shown in Fig. 4. We made a wheeled truck carrying on its bed three sets of rollers running the opposite direction. We suspended from a trestle a riveter large enough to do boiler work from a bail attached through a system of sheaves and tackles to a counterweight of one-fourth the weight of the riveter and having four times the travel. Then all that was necessary to do was to have a small chain block on the trestle to overcome friction of the sheaves and tackle. In that way we could raise this machine with a chain block for any diameter of boiler.

We have in very successful operation a machine with a 10-foot 6-inch gap, weighing about 25,000 pounds. We are now installing several other machines of this character and it seems to be quite a feasible plan. It has several advantages over the ordinary Tower system. It takes up very much less room and the initial cost of installing the plant is very much smaller. This system requires no hoisting of the boiler, as it is simply rolled on the floor or on the rollers. Thus the power plant of the machine is limited to that necessary to actuate the toggle. This is shown in Fig. 4. Fig. 5 shows rivets driven through different thicknesses without adjustment.

Large Two-spindle Gun-barrel Drillers with Motor Drive

We illustrate herewith a large motor-driven two-spindle gun-barrel drilling machine which is one of two such tools recently built for the French Government by the Pratt & Whitney Company, Hartford, Conn.



LARGE TWO-SPINDLE GUN BARREL DRILLER

The two spindles of these machines will drill holes 4 inches in diameter, 113 inches long, or will ream and drill holes 111 inches in length. While primarily designed for drilling gun barrels, these machines are adapted for the drilling of hollow spindles, bridge pins and locomotive axles, their use having been greatly extended by the recently introduced practice of boring out pins, shafts and axles in order to obtain a positive knowledge of the interior structure.

The work is driven by means of the chucks carried by the spindles and is supported by split bushings carried in rests on the bed. The drills are carried by holders secured to the carriages, and have variable power feeds. Each spindle has an independent drive by a 7 horse-power motor mounted on an extension at the end of the bed, and an independent high pressure oil pump is provided for each spindle, for forcing oil from the tank through the drill to cool the cutting edge and force out the chips. These two pumps are operated by a 5 horse-power motor placed at their rear as indicated in the engraving

The drills are carried in holders secured by swinging caps on the carriage blocks and to remove them it is only necessary to release a couple of swinging bolts and open the caps, when the drills may be lifted out of place. For reaming, the open chucks shown are useful, the reamer head being put through the chuck opening and secured to the bar, which is then pulled back from the work to ream the hole. The feed trip which is connected by a pair of links with the reach rod extending along the bed is automatically operated by the carriage when traveling in either direction.

Oil motors for driving machinery are used very considerably for driving the drilling machinery in prospecting wells and for pumping installations in the Baku district of Russia. These motors must be made to burn crude oil, as kerosene or benzine is too expensive. There is a small but increasing demand for motors for boats, steam tugs, etc., and these also must be made to burn crude oil. Air compressors for pumping oil wells are also being considerably used now, and are of the American type and supplied from America, though the Germans have lately placed one on the market.

Torsiometers as Applied to the Measurement of Power in Turbines and Reciprocating Engines *

By Archibald Denny

When the suitability of the turbine method of propulsion for commercial work was proved by the success of the "King Edward," built by my firm in 1901, it became apparent to us that it would be highly desirable to have a method of ascertaining the horse-power transmitted by the turbine shafts to the propellers. Until that problem was solved we could only work from the boiler to the propeller, and the efficiency of the turbine and the propeller must be lumped together. It is not possible to "indicate" the turbine in the same way as is done for a piston engine, although I may say that a fair approximation can be got by ascertaining the fall of pressure through successive expansions by means of pressure gages fixed to the turbine casing. Some 15 years ago we had made numerous experiments with factory shafting, endeavoring to ascertain the absolute torsion of a shaft while running, and it therefore immediately occurred to me that this was the proper direction in which to attack the problem. We had tried various methods, principally using pierced disks and beams of light, but with very partial success. We had not tried any method involving the use of electricity, and I therefore arranged for experiments to be made by this method, on one of our factory shafts. The first trials were made by fixing disks on the shaft at a considerable distance apart, so as to get a reasonable amount of torque. The disks were of insulating material, and each had a contact point arranged at its periphery in such a manner that the point made momentary contact with a metal tongue or brush once in every revolution of the shaft. The contact points were connected to the shaft, and the metal brushes to a battery, and a telephone receiver. The method adopted was to first adjust the brushes, so that both made contact with the points simultaneously when the shaft was revolving, but transmitting no power. When transmitting power the shaft was, of course, subject to a certain amount of torsion, and thus the brushes were put out of simultaneous contact. One of the brushes was then moved round its disk concentrically, until simultaneous contact was once more established. The amount of this shift gave a measure of the torque on the shaft, and to ascertain the correct amount of this shift the telephone receiver was placed to the ear, no sound being heard except when both brushes were in contact with the respective contact points, when a loud "tick" was heard. The principle was thus of extreme simplicity, and the method of carrying it out seemed at first equally simple; indeed, I may say that this first rough apparatus, which was quite successful, only cost a few shillings to make. We then set about making more accurate and elaborate apparatus on the same lines to be fitted to the "Queen Alexandra," which was nearly ready for trial, with an assured hope of getting satisfactory results.

The factory shaft on which we made the original experiments ran about 120 revolutions per minute, but the revolutions of the "Queen Alexandra's" side shafts were over 700, and when we came to make experiments at this high speed we found the new apparatus was useless, as no certain sound could be got. We tried many forms of contacts, and after numerous experiments we did succeed in the "Queen Alexandra," with revolutions about 750, in getting some fairly consistent results, but it was impossible to be quite certain of the exact point at which the make and break in the circuit took place, and we were never quite sure of our results; still, we had made a great step in advance.

Charles Johnson, a member of our staff, who assisted in working out this problem, and was closely connected with it from the first, thoroughly appreciated the difficulties, and realized the desirability of getting away from the unreliable rubbing contact, and he ultimately succeeded in solving the problem in a most ingenious way.

Fig. 1 shows his original instrument. Two gun-metal wheels were fastened to the shaft at a definite and known distance apart, the distance being as great as possible. On each wheel a permanent magnet, with a sharp chisel-shaped edge, was fixed radially at the periphery of the wheel, and with the sharp edge parallel to the shaft. At one end a soft-iron electromagnet wound with fine wire, similarly chisel shaped, was fixed, so that the moving magnet passed directly over the electromagnet once in each revolution. At the other end a similar electromagnet was mounted on a screwed sector, and wires from these electromagnets were led to a differentially wound telephone receiver. If the shaft revolved without transmitting power, the permanent magnets passed these electromagnets simultaneously, and currents of electricity generated in each coil passed through the telephone receiver, but the currents being equal and opposite, no sound was heard. When the shaft transmitted power, the permanent magnets passed the electromagnets at different times, and hence a sound was heard in the receiver. By turning the hand wheel shown in diagram a new position of silence could be obtained, when it was evident that the two permanent magnets were again passing the electromagnets simultaneously, and the amount of torque could be ascertained from the reading of the sector screw.

This instrument was used on a number of the turbine vessels built by my firm

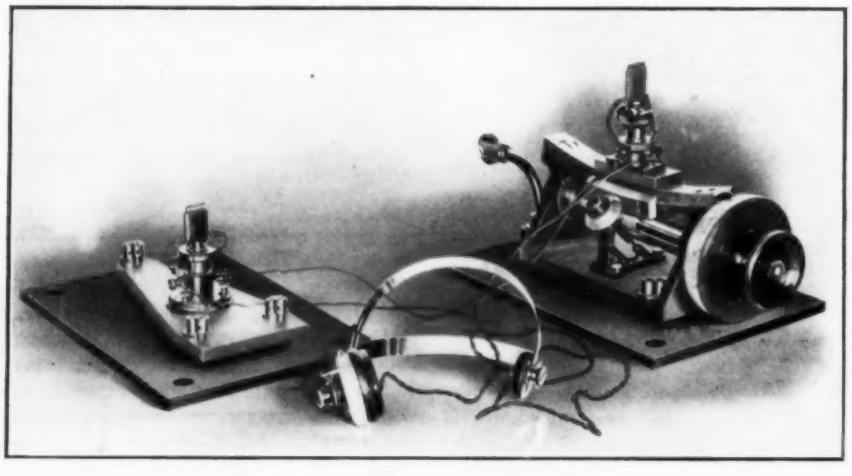


FIG. 1. THE ORIGINAL TORSIOMETER

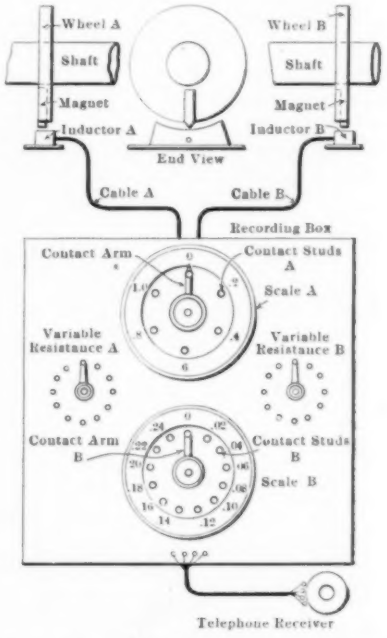


FIG. 2. DIAGRAM OF IMPROVED TORSIOMETER

*Abstract of a paper presented to the Institution of Naval Architects.

with great success, but it required the operator to work in the tunnel, where even with turbines there is some noise and disturbance, and to overcome this objection Mr. Johnson designed another arrangement, which is illustrated in Fig. 2. The gun-metal wheels and permanent magnets remain as before, but in place of the chisel-shaped electromagnets, soft-iron sector cores, marked inductors *A* and *B*, take their place. These cores are wound with a series of coils of very thin wire, so fine, indeed, that each coil, with its dividing wall in one of the sectors, only occupies a space of 0.02 inch. This sector, or inductor as we term it, is fitted underneath one of the gun-metal wheels, and a similar one is fitted at the other wheel, but in this case the coils are farther apart, namely, 0.2 inch; the reason for this will be afterward explained.

In Fig. 2 is also shown the recording box, which will be seen to consist of two circles fitted with contact studs and movable contact arms; the upper one, marked scale *A*, is connected with the inductor at the wheel next the propeller, and has six contacts; that is to say, there are six coils, spaced 0.2 inch apart. The other one, scale *B*, has 13 contact studs, which are similarly connected to 13 coils on the inductor at the turbine end of the shaft; these coils are spaced 0.02 inch apart. On the recording box will be seen two side coils, marked respectively resistance *A* and resistance *B*. These are resistance coils for throwing into series with the differential windings of the telephone receiver, which is connected to the two inductor circuits, which circuits must be accurately balanced before absolute silence can be got in the receiver.

Fig. 2 shows the arrangement of the apparatus for one shaft. With this arrangement it is possible to locate the observer in any part of the ship, cables being led from the inductors in the tunnel to the recording box, and we usually select some quiet cabin where the observer will be undisturbed. The sound in the receiver at usual revolutions is so distinct that even an untrained observer, after a very few minutes' practice, can get perfectly accurate results, and powers transmitted can be ascertained from moment to moment.

It is essential, of course, that the correct zero position, from which to start, should be found. In order to do this, zero lines, or rather grooves, are cut into

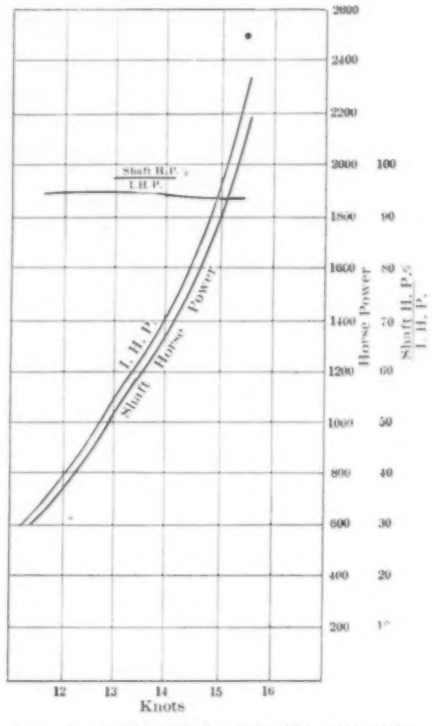


FIG. 3. TURN SCREW STEAMER SHOWING INDICATED H.P. AND SHAFT H.P.

the cover plate of the inductors *A* and *B*, directly over the zero coils, and in setting up the instrument the chisel-shaped magnets are brought directly over these lines, by first dropping them exactly into the grooves, and then raising and fixing them to just clear the top of the inductors. But we do not depend upon this method alone, because any inaccuracy in setting up the inductors might bring in small errors. We therefore get an absolute zero by running each shaft light alternately; that is to say, before the commencement or after the completion of the trials, each shaft is alternately run light, the vessel being driven by the other two screws. It is true that by this means we do not eliminate the effect of friction in the turbine and shaft bearings, but this must be very small, as we find our original method of setting the zero, when carefully done, is always confirmed by this method of checking.

To take a reading after the instrument is once set, and the resistance of the two telephone circuits is adjusted by means of the variable resistances *A* and *B*, all that is necessary is to turn the movable arm on scale *B*, round the various studs until there is silence in the telephone, when the amount of torsion is immediately read off the scale. If no such position be found, it means that the shaft is being twisted more than is covered by this scale; the arm *A* is then turned to the first contact, and the arm *B* is again swept round the circuits. If silence be still not obtained, the arm *A* is turned to the second contact, and so on, the combined range of the scales being altogether 1.24 inches, which is more than sufficient to measure the maximum torque usually obtained. From torsion experiments on the shaft, described herein, made previous to its being fitted in the ship, or from a formula also given, the factor by which this reading is to be multiplied is obtained, and the power is got by a simple multiplication sum.

This instrument is made for one, two, three, and four shafts; for each shaft a group of circles as shown is required. By means of the contact arms and studs the various shafts are thrown into circuit with their receivers, and readings are taken from three or four shafts in a very short time. This instrument is not suitable for very low revolutions, as the induced current becomes too weak to make a distinct sound in the telephone, but it is suitable

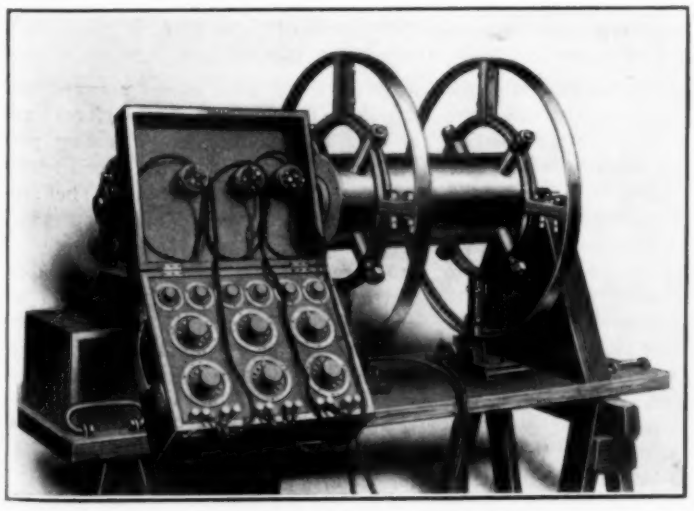


FIG. 4. INSTRUMENT FOR THREE SHAFTS

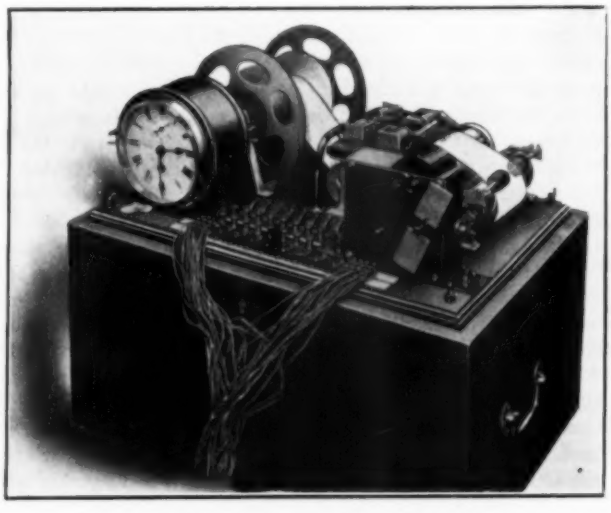


FIG. 5. TIME AND REVOLUTION RECORDER

down to about 100 revolutions per minute. For lower revolutions the instrument first described is employed, but the operator must then be in the tunnel.

The testing of the shaft to get the torsion scale previous to its being fitted on board is done by fixing rigidly one end of the length of the shaft to be used for the trials, and at the other end fitting a lever; this is loaded with weights so as to get the scale of torsion moment. For turbine shafts, which are small in diameter as a rule, this is not a serious operation, nor, indeed, have we found it so even for larger ordinary twin-screw shafts, although, of course, the weights used have to be much greater. We have tested all the shafts for the turbines and other vessels on which we have used these instruments, and we find that the torsion is given very closely by the following formula:

$$\theta^\circ = \frac{W R L}{K d^4},$$

where

θ° = Angle of torsion in degrees.
$W R$ = Foot pounds turning moment.

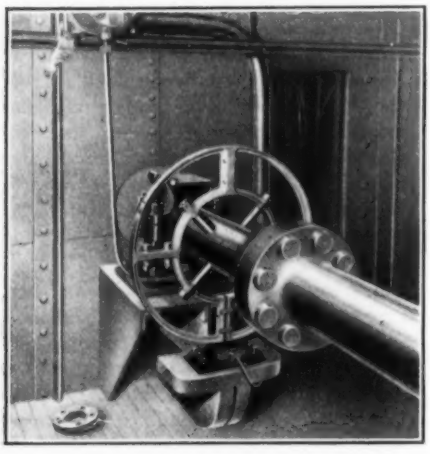


FIG. 6. A MAGNET WHEEL ATTACHED TO A SHAFT

L = Length of shaft in feet.
d = Diameter of shaft in inches.
K = Coefficient.

K may be taken at 140 for mild-steel shafts where there are no couplings, or, if there be any, by deducting their length from the length of shaft twisted; that is, we assume that the couplings do not twist. It is, of course, better to test each shaft independently, but the error would not be great by using the formula, probably not 1 per cent. either way.

While this instrument was designed primarily for turbine engines, it was quite natural that we should attempt to use it for ordinary piston engines as well. In that case, however, on account of the variable torque throughout a single revolution, not less than six magnets ought to be fitted round the gun-metal wheel, and six sets of inductor sectors. This has actually been done in the case of two small twin-screw vessels with success, but it was a very cumbersome arrangement. The diagram in Fig. 3 gives the results of some of these experiments, from which it will be seen that they are very consistent, and show about 94 per cent. efficiency for the steam engine.

Fig. 4 shows a set of recording instruments for three shafts, and the wheels and sectors for one shaft fitted to a dummy; the actual instruments are exhibited on the table. Fig. 6 shows one of the wheels as actually fitted in a tunnel.

As a still further convenience, we use on all our trials of turbine vessels another instrument, shown in Fig. 5, with a roll of paper on which a time pen works, and also pens recording the revolutions of the turbines, and for convenience, these are only recorded for every tenth revolution of the turbine. This machine is also connected by electric cables with the bridge, by means of which the beginning and the end of the mile can be signaled, and thus we are able at one recording station, to ascertain the mean speed, the mean revolutions, and the mean power, all taken by one or two observers in a quiet and undisturbed cabin.

The great advantage of these instruments is that we separate and define the efficiency of the turbine and the screw, and by this means we have been able to discover which is the best combination for any particular ship.

Steels Molds for Casting Small Parts

By Charles Petitjean

Believing that metal molds for casting small parts from white metal are of interest to the readers of the American Machinist, I show illustrations of two examples of this work and give a description of each.

Mold for an Angle Bracket

The casting is shown by Fig. 1, the mold by Figs. 2, 3 and 4. The mold is made in three main pieces screwed and doweled together. The surfaces are finished by grinding, thus insuring perfectly flat surfaces to avoid formed burs on the edges of the casting. The center piece is grooved to make a channel for the slide which forms the curves of the strengthening ribs of the casting, and it also acts as an ejector to push the casting from the mold. The piece on the edge *A* of Fig. 2 acts as a stop to prevent the slide from being set back too far. The stop is raised up after a bracket is cast, thus allowing the necessary motion required to force the casting out of the mold.

The two hinged pieces *B* and *C* on the sides are held in position by the steel

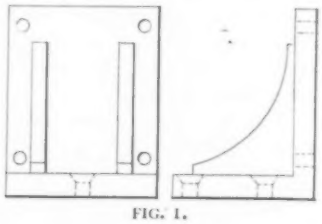


FIG. 1.

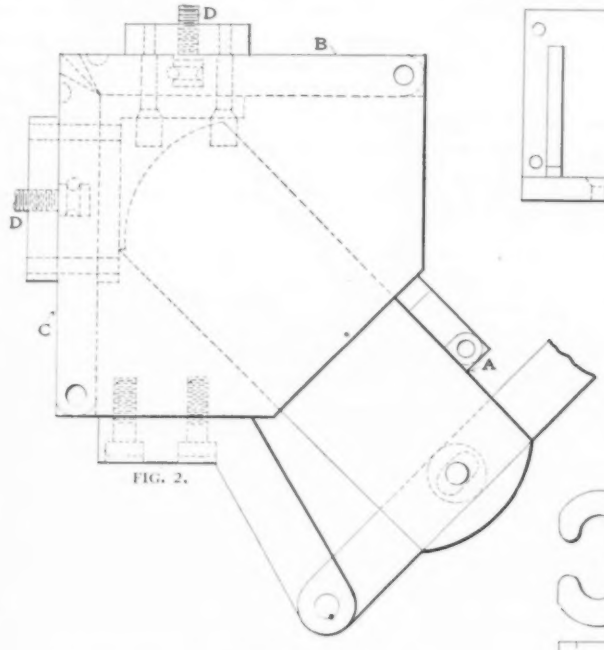


FIG. 2.

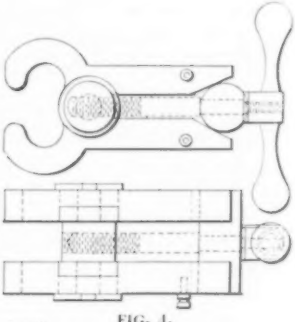


FIG. 4.

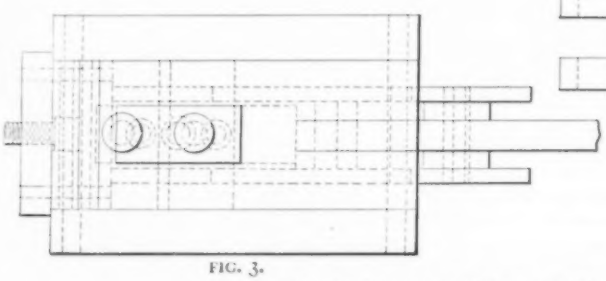


FIG. 3.

MOLD FOR CASTING A WHITE-METAL BRACKET

clamp. Grooves are provided in the hinged sides near the miter joint, into which the jaws of the clamps fit. By screwing down the locking bar, the jaws are tightened, thus closing the joint. The sides are fitted with plates carrying the cores for the holes in the bracket. Two of them are countersunk. They are formed by letting in two steel plugs which are shaped to the angle required. The cores are screwed into the plates, and each plate is provided with a tapped hole, for the screw *D*, which is a running fit in the side plate and is held in position by a pin fitted in a groove. Thus it cannot come out when the screw is being turned to withdraw the cores. The screws are fitted with handles, not shown, to facilitate this operation.

The gate is made in the center of the miter joint, is countersunk nearly the thickness of the joint, is the full width of the plate and is about 0.005 inch wide. Through this opening the metal is forced, leaving on the casting a thin fin which is easily broken off.

In operating the mold, it is fixed on a suitable bracket held in a position so that the lever is down and the gate up. The hinged sides are held tightly by the clamp. The hinged stop is put in position, the lever is grasped in the left hand by the operator, the bracket and mold move upward to bring the mold to the nozzle of the melting pot, the metal is forced in, the clamp is released, the cores withdrawn and the sides thrown open. I should mention that the bracket is fitted on a base plate pivoted to swing clear of the melting pot. The stop is now pulled over and the lever raised, forcing the casting out of the mold. A little paraffin was rubbed on the mold seams to make the metal run freely and produce a bright and even surface on the casting.

There are two helical springs fitted on the clamps to keep them open. The jaws of the clamps are made in four pieces recessed so as to form a joint and held together with a shouldered rivet. The upper ends of the jaws are beveled and a ball is pinned on the stem of the screw so that when the screw is tightened the jaws are closed. This is clearly shown by Fig. 4.

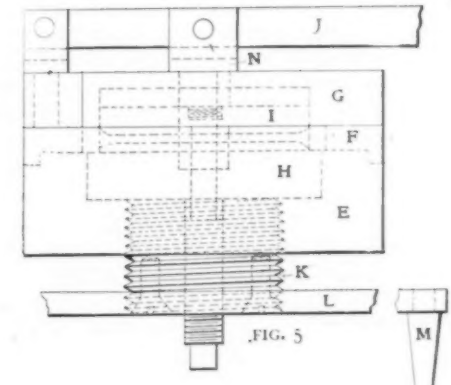


FIG. 5

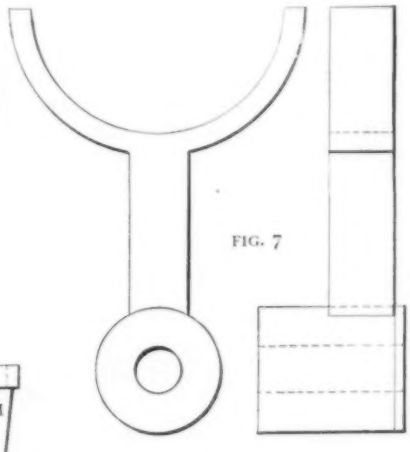


FIG. 7

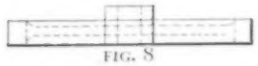


FIG. 8

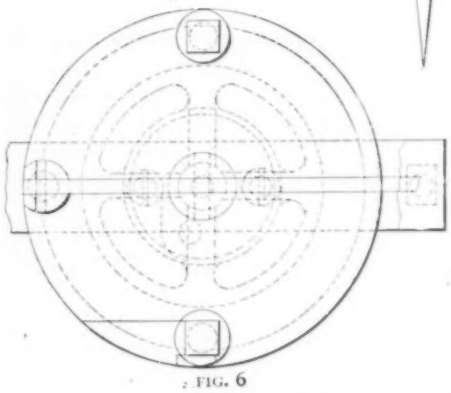


FIG. 6

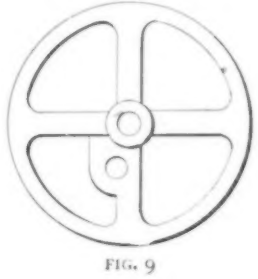


FIG. 9

MOLD FOR CASTING A WHITE-METAL GEAR

Mold for a Gear

Figs. 5 and 6 show a mold for casting small gears such as are used in the magnets of a telephone. Figs. 8 and 9 are two views of the wheel. The teeth are not shown.

The mold consists of three main parts made from mild steel and lettered *E*, *F* and *G*. *E* is the base of the mold, to which is fixed the piece *F* by reducing *E* in diameter and fitting it to the recess in *F*. It is located by a dowel pin and fastened by three screws. The center piece *F* has the teeth cut internally and is made of the same thickness as the gear. *E* is recessed to the diameter of the bottom of the teeth. The part *H* is formed to give the shape of the inside of the rim and from the edge of the rim to the arms. This piece is also used in forcing the casting out of the mold by the screw *K*.

This screw has an arm *L*, with two tangs *M*, one on each end, over which are fitted wooden handles. Through the center of the screw there is tapped a hole for the center core. Its outer end is threaded and fitted into a hole in the plunger screw. It is squared to allow a wrench handle, used in drawing it out of the casting, to be fitted to it.

The top piece *G* is recessed for the former *I*, which is shaped to form the other side of the wheel rim and arms similar to the former *H* in the bottom block. The shape of the arm is machined out so that when the pieces are together they form the gears to the required shape and thickness. The former *I* is made so that when in position in the mold there is room in the recess to draw it clear of the casting. This is done by the stud *N* and the lever *J*. The piece *G* is clamped by two screws. One side is slotted so that when the screws are loosened slightly the piece may be swung clear of the mold, using one screw as a pivot. The screws are provided with a bar spanner in order to be easily handled. The movement on the lever *J* is so slight that the hole in the lever is only slightly elongated to avoid cramping.

The bracket, Fig. 7, is the kind usually fixed on such molds. They are made as nearly to a standard as possible and yet suited to the nature of the work. Thus it only requires a few brackets to handle a large number of molds. They are made of malleable iron and fixed to the mold by two screws. They facilitate the handling of the molds, which can be swung clear of the melting pot, thus giving the operator room to handle the different levers.

L——, England.

Turkish Machine Shops

Consul report from Smyrna, Turkey, states that up to 1857 there was not a factory of any kind in Smyrna which manufactured steam engines or machine supplies. The completion of the Aidin Railway, and the introduction of cotton-growing, which created a demand for iron products, gave an impulse to this industry with the result that there are at present three large machine shops, and a number of smaller factories in Smyrna. The annual output is not known, but is greatly on the increase and the field for machines of every description is becoming a large one.

The shipments of iron, steel and pig iron from Mariupol to Baltic ports amounted to about 25,000 tons in 1906 against 20,000 tons in the previous year.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Case-hardening in Cylinders

About 12 or 14 years ago a couple of us started a bicycle-hub factory, and I believe we were among the first to use case-hardened cups and cones.

We tried tool steel at first, but the result was so unsatisfactory, both in the machining and the staying qualities, that in despair we were literally *forced* to try machine steel. Other factories seemed to have been moved in the same way at about the same time.

Nothing that we could learn about the subject seemed to fit into our needs, so we were compelled to build from the ground up, literally as well as figuratively. As I have seen nothing in use since, that appears to be as cheap, convenient and reliable as what we used for six years, I will describe how we went about it:

Everything was planned out before we did much real work on it, and as a result of careful, critical discussion of every detail beforehand, we experienced very few difficulties in the progress of the work.

Neither of us was blessed with an overflowing purse, so we were obliged to make use of a scrap pile, which fortunately was close at hand. This with a few loads of second-hand fire brick and the use of our Yankee wits, enabled us to start our case-hardening plant at a very small outlay of cash. Most of the actual labor I did personally, my partner looking after the other business of the shop.

The principal thing to which I wish to call attention is the cylinder which we used to hold the articles to be case-hardened, and which is shown in Fig. 1. Pots or square iron boxes were used everywhere, and as far as my knowledge goes are used today. Such forms are not only difficult to handle but are more difficult to heat evenly.

We made ours out of 4-inch water pipe, with ¼-inch wall. This pipe we cut in 3-foot lengths, and threaded on the inside for about an inch and a half in each end.

We then had some plugs cast, as shown at *A* and *B*, Fig. 1. The plug *B* was made a tight fit, and the other end a very loose fit, a rather blunt 8-pitch thread being used. When screwed into place the result was a smooth cylinder with a 2-inch square head, 1 inch long, projecting from each end.

These heads made a convenient means of turning the cylinder, while in the fire by the use of the long socket wrench, Fig 2.

When preparing to dump the contents of the cylinder, the plug *A* was unscrewed with this wrench, while the cylinder was held by the tongs, Fig. 3. Another long pair of tongs, not shown, was also used to shift the cylinders back and forth in the fire. The ends of these tongs were squared something similar to a socket wrench.

We did not reheat any of the articles that we case-hardened, and as far as we were able to ascertain, the results were just as satisfactory as if we had, and we saved the extra expense as well as time.

Our cups and cones we put in as follows:

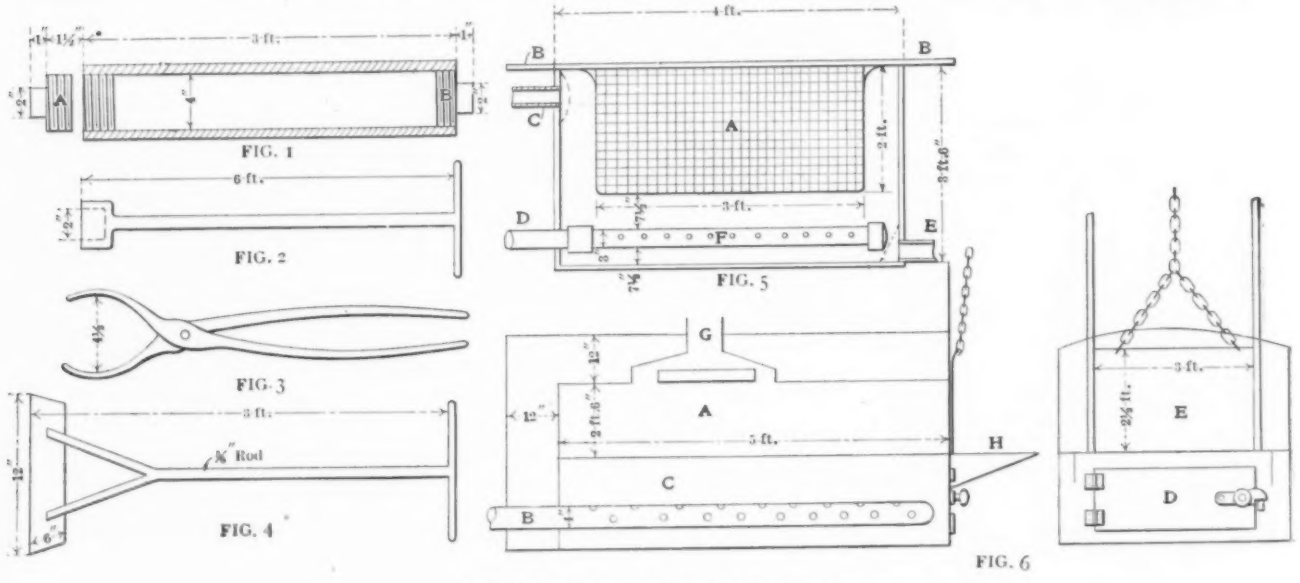
The cylinder was set up on end and two tin cupfuls of ground bone put in, then a cup of cones, or cups as the case happened to be, was put in, followed by another cup of bone and so on alternately till the cylinder was full, two cups of bone being put in last and the plug screwed in.

We used a coke fire and kept the cylinders at a nice cherry heat for six hours, then withdrew the cylinders and dumped the contents into a tank which is shown in Fig. 5. This tank was made of boiler iron and was 4 feet long, 3½ feet high and 3½ feet wide. The basket *A* was made of heavy ¼-inch mesh wire screen, was 3 feet long, 2 feet high and 2½ feet wide, and had two iron handles *B* on each end for convenience in handling and also for suspending in the tank.

The 4-inch overflow pipe is shown at *C*, the mouth protected by ⅛-inch mesh screen, as is also the drain pipe *E*. The inlet pipe *D* was connected direct to the city water supply, the force of which was controlled by a regular 3-inch valve.

One-quarter inch, staggered holes were drilled at an angle of 90 degrees in the pipe *F* in order to throw the cold water as evenly as possible against the bottom of basket *A*.

When cleaning the tank, the basket was lifted out and pipe *F* unscrewed, leaving the tank practically free from obstructions, and allowing burnt bone to be easily removed by a scoop, Fig. 4.



APPLIANCES USED IN CASE-HARDENING

The furnace, Fig. 6, was made of fire brick. The walls were 12 inches thick and bound together with long bolts, bedded in the mortar and fire clay, with heavy iron straps on the outside.

The fire-box *A* was 5 feet long, 3 feet wide and 2½ feet high, and would hold six cylinders and have room enough for a heavy bed of coke. The ash pit was the same size as the fire box, and the air pipe *B* ran from the back, through the middle of it. This pipe had three rows of holes 3 inches apart drilled in it, and was made of 4-inch water pipe. On top the holes were ½ inch diameter and on the sides ¾ inch in order to equalize the air supply somewhat.

The bent pipe is shown at *G*. The bricks were arranged to check the escape of heat as much as possible.

An iron table or shell *H* was placed in front of the door. The ash-pit door *D* was an old furnace door from the scrap pile, as was the grate in the bottom of the fire box. The fire-box door *E* was made of a piece of heavy boiler plate, and was made to slide up and down, a chain and counterweight making it easy. The slides were made of angle iron.

Our blast was furnished by an old 18-inch fan, and stovepipe was used to connect it to the pipe in the furnace; a slide inserted between the fan and the pipe enabled us to regulate the blast or to shut it off entirely.

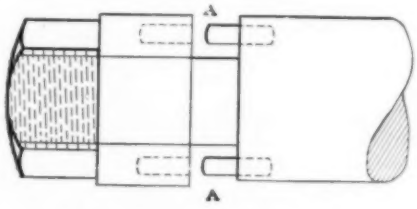
As I said, we used this furnace, cooling tank and case for six years with perfect satisfaction. The shape of the cylinders enabled us to get a more even hardness on our product than I have ever seen produced elsewhere.

ETHAN VIALL.

An Arbor for Slitting Saws

The accompanying cut shows a milling-machine arbor for slitting saws designed to be used for deep cuts or on castings of irregular shape. On this work I had trouble from the slipping of saws held by the friction of collars or by keys, until this arbor was made. The feature of the arbor is the two pins *A* which pass through the saw. On this arbor a 12-inch saw was used, and it stood the test of a very heavy cut on a positive-feed miller.

B. K. WHITNEY.



AN ARBOR FOR SLITTING SAWS

Jig for Finishing Eccentrics at One Setting

Anybody who has had anything to do with finishing eccentrics has undoubtedly run up against the difficulties in such jobs. As I have some time been doing this work on an improved turret lathe, I have myself realized some of the difficulties attached to this job. Recently our general foreman devised a simple jig for boring and turning locomotive eccentrics at one setting.

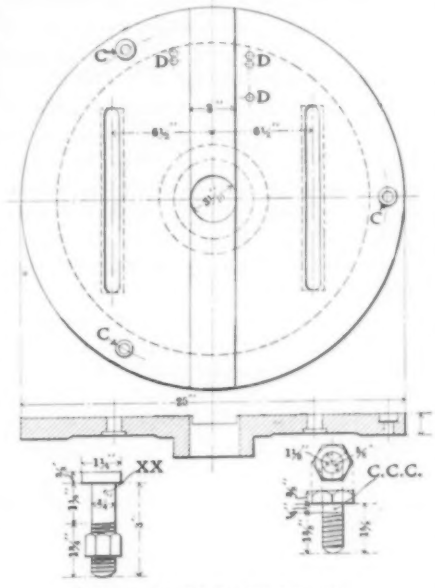


FIG. 1. MAIN PLATE DETAILS

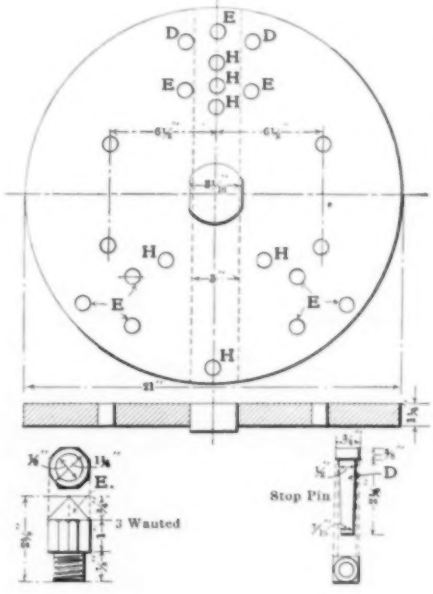


FIG. 2. SLIDING PLATE DETAILS

It consists of two plates, the main plate as shown in Fig. 1 and the sliding plate as shown in Fig. 2.

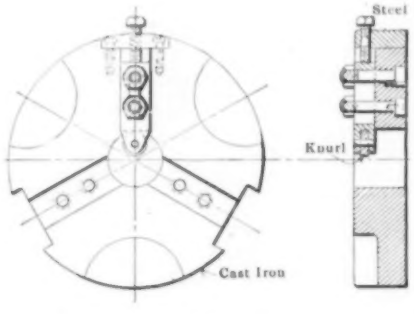
The main plate is secured to the machine by means of the boss on the back fitting into the hole in the chuck (the jaws having been removed) with three cap screws *C C C* through the plate into the chuck. The center slot is to fit a like tongue on the sliding plate. The short slots on either side are to receive the four bolts *x x* which hold the sliding plate to the main plate and are made long enough to allow a shifting of the sliding plate equal to one-half the throw of the eccentrics to be machined. The oblong hole in the center of the sliding plate is made wide enough to clear the boring bar and long enough to permit the sliding of the plate equal to one-half the throw of the eccentric. Holes *D D* shown in Fig. 2 are stop-pin holes which match up with holes *D D* in the plate, Fig. 1. These holes are located at distances from each other equal to one-half the throw of the eccentrics. The holes *E E*, etc., are to receive centers *E* and are located in such a manner as to strike the solid part of the eccentric. Holes *H* are for studs used to clamp the work to the face plate in the usual manner.

W. C. MURPHY.

Nurling Wire in Lengths

In our factory we require a great number of small gages such as pin and disk gages which are used in the manufacturing departments, and as is the usual case the handle or grip is nurled. As it is a costly job to nurl the wire or rod in a lathe and also an injury to the lathes to do so, we made the nurling tool shown in the sketch. This tool enables us to nurl up a stock of wire or rod in 2-ft. lengths, which is cut up and used as required.

To use this tool we clamped it to the table of a drill press and by pushing the wire or rod right down through the nurls as far as the travel of the spindle would permit, we loosened the drill chuck, raised it, took a new grip on the wire and pushed it down through as far as it would go again. In four or five moves we could nurl all but a couple of inches on a 2-foot piece of wire or rod.



NURLING ON THE DRILL PRESS

The nurls can be set to nurl wire from ⅛ to ½ inch, and if the tool is made to accommodate it you can nurl rod as large as 1¼ inches.

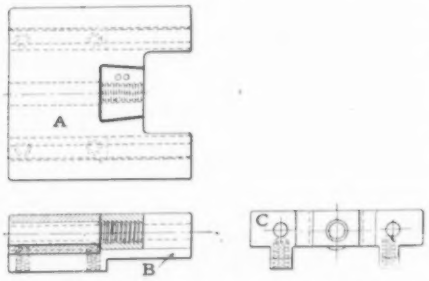
The wire or rod after going through the nurls is better than that which is nurled

in a lathe. The whole length nurled is the same and has no stopping places nor bad spots.

The illustration shows the tool with only one of the nurls. Of course there should be three of them, all like the one shown in position. B. T. ROBERTS.

Repairing Milling-machine Vise Nuts

The illustration shows how to repair a milling-machine vise in case of the thread in the nut of the sliding jaw stripping.



REPAIRING A MILLING-MACHINE VISE NUT

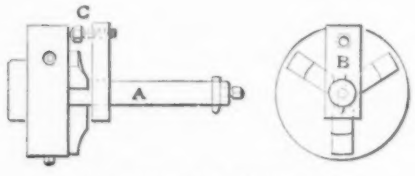
A is a plan of the sliding jaw and *B* is a side elevation. *C* is an end elevation, and *oo* is a bronze nut set into the the sliding jaw as shown. Referring to *B*, you will find the nut shown in position by the shaded section.

My experience has been that in every case where a vise breaks or strips the thread, a new sliding jaw is bought at a cost of ten times the cost of repairing one after the plan as shown in the drawing inclosed. It is a very short job for a machinist to put in a new nut.

THOMAS F. KEAN.

An Adjustable Boring Bar

A hurry-up scheme for an adjustable boring bar is shown in the accompanying cut. It is such a device as the mechanic works out for himself when left to his



AN ADJUSTABLE BORING-BAR

own resources, if he cannot find a suitable tool to do the job.

The device needs little explanation. The adjustments of the bar *A* are obtained by the screw *C*, which passes though the plate *B* and bears against the face of the three-jawed chuck.

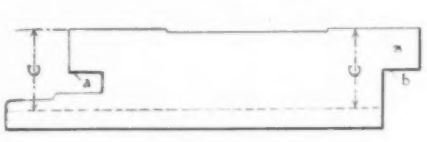
G. V. HUBER.

Working to a Finer Limit than Necessary

It does not seem to be generally known that the planing and fitting up of a cross rail for a large boring mill is a very nice piece of work, more so than the cross rail on a planer. The face of the rail on a boring mill must be square with the table, also the saddles and bars, in order to bore straight holes, while if the face of the rail on a planer is not square it does not matter, except in case it might be used to set work by.

Any conscientious machinist is pleased at the sight of a nice piece of fine, clean work, even if done by a rival shopmate; but at the same time he does not like to see a lot of time put in on a job in making it too fine. By this I mean work that is really not necessary to improve the machine being built.

When finishing work on the planer I have found that it is a good plan to find out just how the work is to be handled by the men that fit it. I had finished a boring mill cross rail on the planer, supposing that when scraping and fitting the saddles to it the rail would be leveled crossways on each end by using wedges under the four corners that would bear against the housings, but instead of doing it with



THE JOB

four wedges, but two were used. As the rail was set upon three points only, it showed a twist of about 0.002 inch, and a surface plate was used to scrape it out.

Although these rails were as stiff as any generally used by others, they had a "give" of about 0.004 inch on a twisting strain; this would amount to nothing when the rail was bolted in place.

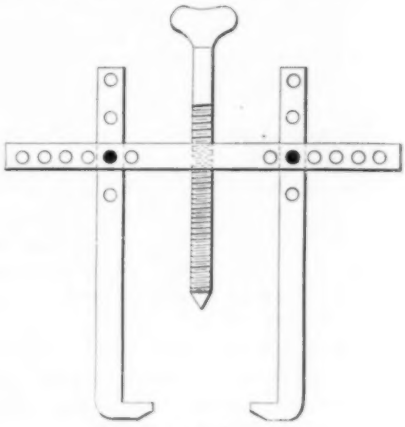
It will be readily seen that if the rail had 0.004 give in it, that the 0.002 could have been leveled out of it and have saved a lot of scraping; for, as the back parts of the rail were finished an even thickness with the face, whatever twist was taken out of one side would also have to come off of the other side to get the face square with the table.

Doing the scraping on three points was the finest way to work, and I don't wish to make any excuse for the planer work, as I had no trouble of the kind after I found the method used in scraping and fitting; but I think the method used was finer than was required to get the same results or as good.

The rail was about 6 feet long, as per sketch. A solid gib was used back of bearing at *a* and *b*, and the job had to be an exact thickness through *C C*. To get in and scrape a thousandth along bearing *a* is hard work, as the saddle, when gibbed up, had to slide along smoothly and show a nice full bearing. H. L. CAMERON.

Diemaker's Clamp

I inclose sketch of diemakers' clamp, which I have used with much success. The jaws are adjustable to different sizes



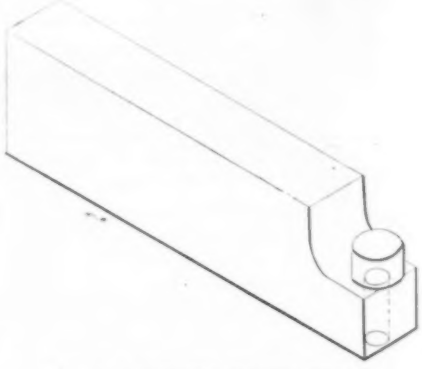
A DIEMAKERS' CLAMP

or diameters of work and can therefore be kept in a vertical position, holding the objects more firmly.

LEWIS L. LEIGH.

Tool for Cutting Grooves in Circular Tools

We use a tool in our shop, which manufactures fishing reels, that saves us a great deal of time and trouble. The idea may not be new, but in the making of circular tools for automatic screw-machine work running up to three-eighths stock it has become a permanent fixture. It is



TOOL FOR CUTTING GROOVES IN CIRCULAR TOOLS

used in cutting radii on circular tools and consists of a bar of soft steel to suit the tool holder it is desired to use it in.

One end is shaped down a sufficient distance to allow a short length of drill rod or Stubs steel to be placed upon it perpendicularly and still let the top or cutting edge come to the cen-

ter of the work as in the sketch. In this depression a hole is drilled and reamed. This end is then case-hardened.

Suppose in making a circular tool it is desired to cut a radius of say, 0.156 inch. We obtain a piece of drill rod of the required diameter, which would in this case be 0.312 inch, and turn down the end to fit the drilled hole tightly. We then harden it and are ready for business.

We found it very tedious filing out a tool every time one was wanted, also quite liable to inaccuracy, so this was the result.

As the tool must be worked at the center line to bring accurate results and we usually make the circular tools about 2½ to 3 inches in diameter, very little or no clearance is necessary. A. DUBLING.

Fastening a Head on a Bar, without Pin or Solder

Some years ago the writer had occasion to fasten a cylindrical brass head on a sheet-steel bar, the width of which equaled the diameter of the finished head, the thickness of bar being 0.030 inch. This was a job where pinning or soldering was tabooed.

The job was most successfully performed in the following manner: First,

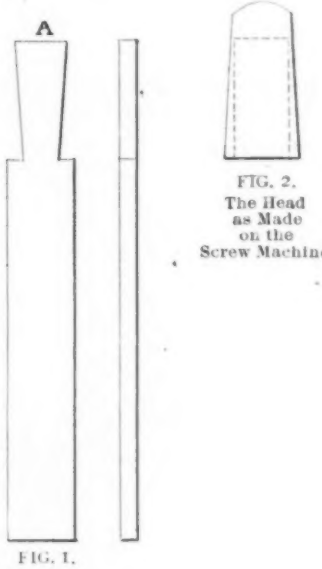


FIG. 1. The Bar as Punched.

FIG. 2. The Head as Made on the Screw Machine.

FASTENING A HEAD ON A BAR, WITHOUT PIN OR SOLDER

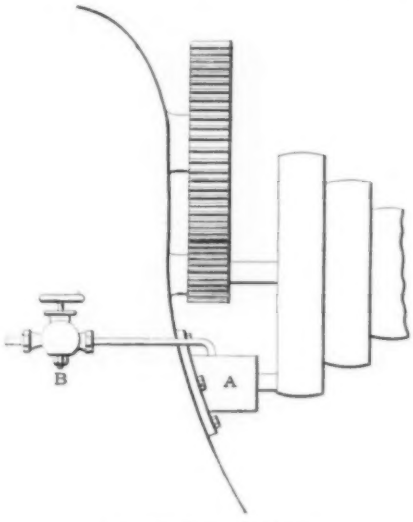
the sheet-steel bar was punched like Fig. 1, the top end being left what we call "back-tapered" 3 degrees on a side. Then the brass head was made in a screw machine like Fig. 2, the hole being the same diameter as the distance across Fig. 1 at *A*, which was perhaps 0.02 inch less than the full width of the bar. The outside of the head was tapered to correspond with the top end of the bar, and the two pieces were then put together and by the aid of a foot press forced through a round die the size of the small end of the brass head. After passing through the die the head was straight, smooth and neat, and fastened as securely as though made of one piece. I inclose for the editor one of the pieces for examination. E. E. N.

[In the specimen received the head is quite firmly fastened on.—ED.]

A Brake for a Slotter

Here is a simple brake for a slotting machine, which is used with success as a time and labor saver by the American Brake Company.

It consists of a cylinder *A*, 4-inch bore, ½-inch stroke, with a leather head on the



A BRAKE FOR A SLOTTER

piston, operated by compressed air. It is bolted on the machine back of the cone. The air valve *B* is located on the front of the machine. CHAS. G. HOWELL.

A Core-print Idea

The letter from F. W. Barrows, on page 568, strikes that turbine in my head which works when there is a trouble to get over.

About 25 years ago I explained in a paper before the A. S. M. E. a core-bar arrangement in which the ends of the core are cast-iron bushes on the core bar, and of the same size as the sand core.

These bushes have small rings around them, which dent into the sand an inch or so back from the end and effectually prevent the flowing of the iron past or out of the mold. We have continued this ever since, but I have been too stupid to apply the idea to regular core work.

How perfectly simple it will be to get over the trouble Mr. Barrows explains—by simply turning a flat V or half-oval groove about midway of its length in every core print where the core is to lie horizontally. This will leave a small ridge of sand in the mold for the core to crush down, not enough to disturb the mold if the core is full size, and enough to hold the core central if too small; besides, it will prevent the iron from cutting off the vent.

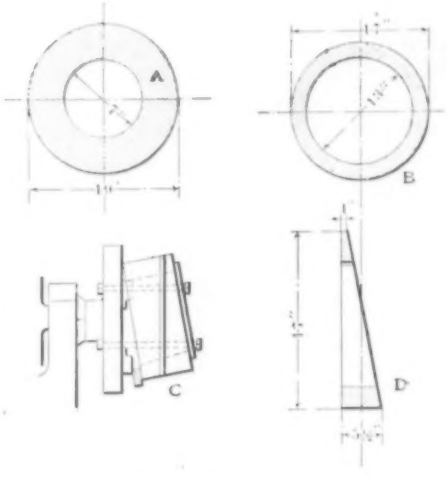
JOHN E. SWEET.

Making a Bevel Pipe Fitting

I am interested in the odd jobs and experiences of other mechanics, and have a little one of my own which may help someone else. My work is mostly anything in the line of repairs and renewal of parts of engines, pumps, air compressors and pipe lines. They wanted to change one of these large water lines that furnish water to prepare the coal for market. It was to be fixed on Saturday, so as to have it ready to resume work on Monday.

Not having regular standard length of pipe, when they came to finish they had to have a bevel ring to make the right elevation. There was no time to have one cast in town, which is three miles away; something had to be done and done at once. So the superintendent sent for me and wanted to know whether I could make a ring to suit the place.

After looking around I found a piece of casting that would fill the bill with a lot of work, so I started in on the job. The ring when finished was to measure 17 inches outside diameter, 13 inches inside diameter and bevel from 5½ inches to 1 inch, which is quite a bevel.



MAKING A BEVEL PIPE FITTING

The piece of casting that we had on hand was the sinking head from a casting made for a pump plunger, and was 19 inches outside diameter by 7 inches inside diameter by 6 inches long. So we rolled it in the shop and up on the lathe with a 30-inch swing, got it chucked and commenced to bore the inside to increase the diameter from 7 inches to 13 inches. Then I finished the outside down to 17 inches as far as the jaws would permit, and faced the outside end. Then I turned it end for end in the lathe and finished

the other end and the balance of the outside that was left standing in the jaws.

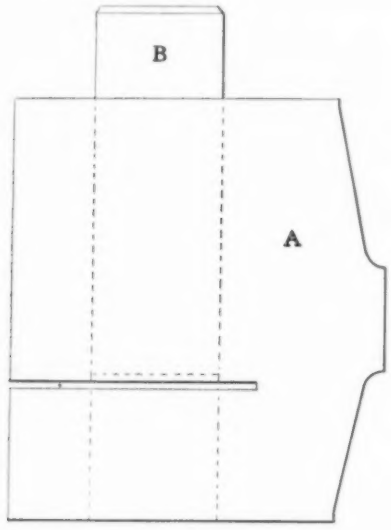
The next job was to cut the bevel. We had a Sellers planer, and the superintendent proposed putting it on the planer and machining it there. He thought we could make more headway there than any other way. But I proposed leaving it in the lathe, as I thought it could be done in a very short time. I blocked out the work on the chuck to the required bevel, and then bolted it fast and made one complete cut through the ring, and we had the bevel as nice as you please.

Referring to the sketch, *A* is the piece in the rough, *B* as it was finished to the measurements, and *C* is the manner in which I held it in the chuck with bolts and clamp across the outside, three jaws on the inside of the hole, and a block of hardwood against the one jaw that was out of commission on the bottom.

D. R. Llewellyn.

A Neat Makeshift Punch

Recently I had to make in sheet tin some articles which required about 70 or 80 holes 1 inch in diameter near one edge. We have no press tools in the shop, so I took an old 15/16-inch solid bearing, reamed it out to 1 inch in the drill press and fitted in fairly tight a piece of 1-inch cold rolled shaft. I then sawed it nearly through with a hack saw, going just enough past the bore for the bottom of the saw cut to act as a stop. On inserting the tin in the slot, a light tap with a hammer produced a perfectly clean hole dead to size. The first 15 or 20 were without any bur, and even the last few were plenty good enough. I have subsequently punched holes this way in both steel and brass up to 1/16-inch thick, but, of course, it is only a makeshift, though it works very nicely for a few holes.



A NEAT TEMPORARY PUNCH

A is the old bearing, with a 1-inch hole. *B* is the piece of cold-rolled shafting, *C* the saw cut. The tin is inserted in *C*, *B* is pushed down till it touches the tin, and a light tap with a hammer does the rest.

I would like to thank Ethan Viall, through your columns, for his flux for brazing cast iron. I have used it successfully several times, and find it quite simple and very effective. I find, however, that it seems to harden the iron considerably, though in most cases that is no disadvantage. Also I found it much easier to braze steel to gray iron than two pieces of gray iron together.

John P. Wheeler.

A Cheap Ball-bearing Swivel—Correction of Boring-tool Sketch

I inclose herewith a sketch of a cheap ball-bearing swivel that may be useful to some of your readers as it is to us. The shank of *b* is turned and a groove for the balls is turned in it 1/16 inch less in depth than the radius of the balls you want to use. Then bore *a* to admit *b*, and counterbore it 1/16 inch larger than the diameter of *b* at the bottom of the groove plus twice the diameter of the balls, properly rounding the bearing *d*. Then drill a hole through *a* the proper distance from seat *d* to admit of a pin being driven through and riveted as at *c*, Fig. 1. Now hold the parts in the position shown in Fig. 2, pin *c* being inserted on the under side to prevent the balls falling through, and drop in the balls; pull out on *b*; that will seat the balls and admit of the pin *c* being driven home and riveted, which completes the swivel as in Fig. 1.

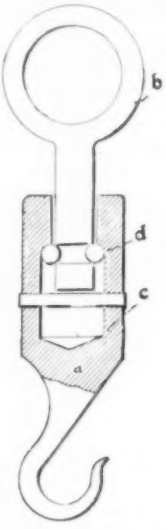


FIG. 1. VERTICAL SECTION OF SWIVEL.

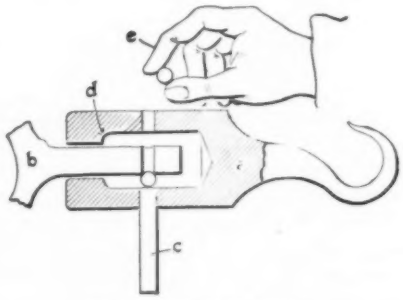


FIG. 2. PUTTING IN THE BALLS.
A CHEAP BALL-BEARING SWIVEL

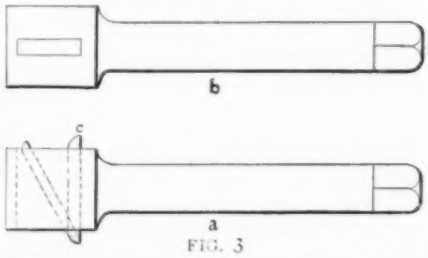


FIG. 3

TOOL FOR BORING A TAPER-CHAMBERED HOLE

Corrected Sketch of Tool for Boring a Taper-chambered Hole

I also wish to correct the sketch of tool for boring taper-chambered holes, shown at page 319, Vol. 30, Part 1. As published it shows a collar at the back of the cutter *c* in Fig. 1, which should not be, as that would stop the chips from escaping. It should be made as per accompanying sketch, here marked Fig. 3.

J. W. Watson.

A Simple Method of Making Exact Templets from Gear Teeth

The old, laborious method of cutting and fitting, or trying to fit, templets to gear teeth is both tedious and expensive, and is rarely more than a rough approximation to what is wanted.

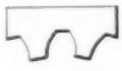


FIG. 1.

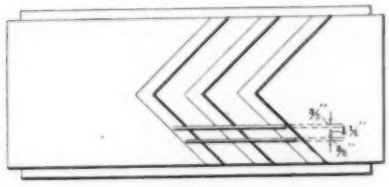


FIG. 2.

FIG. 3.

TEMPLETS FOR GEAR TEETH

The problem stated below, which recently confronted the writer, is one which in some form is often met with.

Problem: Given a large pinion with helical teeth shrouded at both ends and no drawing; determine the exact outline of tooth so that another gear may be made to mesh properly with the old pinion.

Solution: Two pieces of 3/8-inch dressed pine were cut to fit very roughly over the teeth (see Fig. 1). These two pieces were set at right angles to the

center line of the pinion shaft (see Fig. 2) and were held parallel by two small distance pieces which separated them 1¼ inches. Fire clay was used as a backing, and molten babbitt was poured between the boards until the teeth were entirely covered. As the teeth had been previously cleaned and coated with graphite and oil, the babbitt did not stick, and when cool it was lifted out of the teeth, giving a perfect templet, as shown in Fig. 3.

The templet was then laid flat on the drawing board, and by running a pencil along the edge the tooth outline was reproduced on paper.

MONROE R. HILL.

A Spring-winding Device and Cutting Rig

Having seen a good many devices in the pages of the AMERICAN MACHINIST for winding initial-tension spiral springs prompts me to send a method I have devised and used, as I have not seen anything like it. Referring to Fig. 1, the

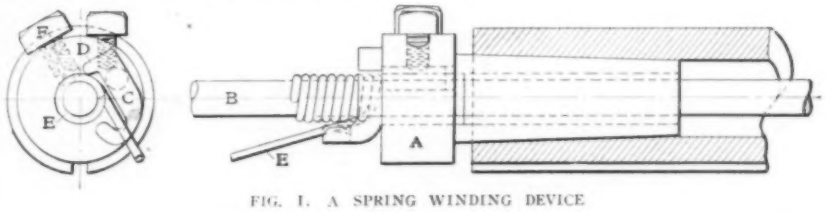


FIG. 1. A SPRING WINDING DEVICE

device principally consists of a plug *A* of case-hardened machine steel to replace the center in the lathe footstock. It is bored to accommodate various sizes of bushings, the bush in the drawing being hidden by the spring *E* in the end view. This bush is bored, hardened and lapped to form a running fit for the mandrel *B*, on which the spring is wound. The bush is held in place by a screw *F*, which has

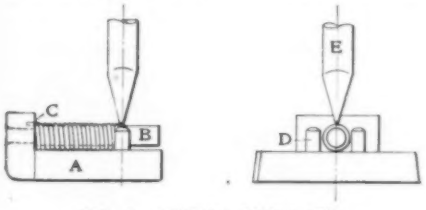


FIG. 2. CUTTING THEM OFF

a hole through it for oiling the bearing. On the face of *A* a guide *C* is fixed by means of its stem, and a screw.

In the end view it will be seen that one end of the wire guide rests on the spring being wound, while the other end bends outward to guide the wire, as shown in the side view. By means of the screw the guide can be adjusted and fixed in different positions to allow various sizes of wire between the end *D* and the mandrel *B*, in conjunction with the bearing bush for different sizes of mandrels. The guide is hardened and tempered steel finished smoothly at *D*, and the hooked end, which is also rounded to prevent wear from the wire *E*.

To operate the device the plug is fixed in the footstock barrel, with the feed screw removed to allow access to the mandrel *B*, the barrel being clamped. The guide is adjusted, to just allow room for the wire between the end *D* and the mandrel *B*, and firmly clamped. The mandrel *B* and the wire are caught in the lathe chuck and the footstock moved up to the chuck, the lathe being given a few turns to bring the spiral under *D*, and the feed wire over the hook. The footstock is loosely clamped down with a spring plate washer, to allow it to slide along the ways. The lathe is then started and the spring will run itself without any attention beyond keeping up the feed.

In this instance the lathe is reversed to allow a better lookout for kinks. For the mandrels *B* I use hardened steel drill rods of such lengths as not to buckle, the sizes of which, of course, have to be found for different sized springs and wires. It is surprising the amount of "whip" that can be gotten on a spring ¼ inch diameter of say 0.02 inch steel wire. The device has proved very satisfactory on springs up to ⅜-inch diameter with 0.10-inch wire, and no doubt would also on larger sizes.

Fig. 2 shows a simple arrangement for cutting off the springs to length and to an exact number of complete convolutions. It consists of an angle piece *A* to fit a dovetailed bolster of a hand press, carrying a steel core *B*, which fits easily inside the spring to be cut. The horizontal part of the angle has two steel pins *D* fitted to prevent side movement of the spring under the cut of the chisel punch fitted in the press ram. The vertical portion has a small pin *C* against which the end of the springs butt to insure being cut with a complete number of turns.

W. MADDISON.

A Gaging Countersink

The drawing shows the depth-gaging countersink, which I designed. The tool proved a great success on castings that varied in thickness, as they could not be

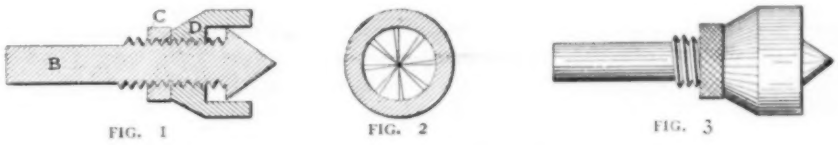


FIG. 1 FIG. 2 FIG. 3

A GAGING COUNTERSINK

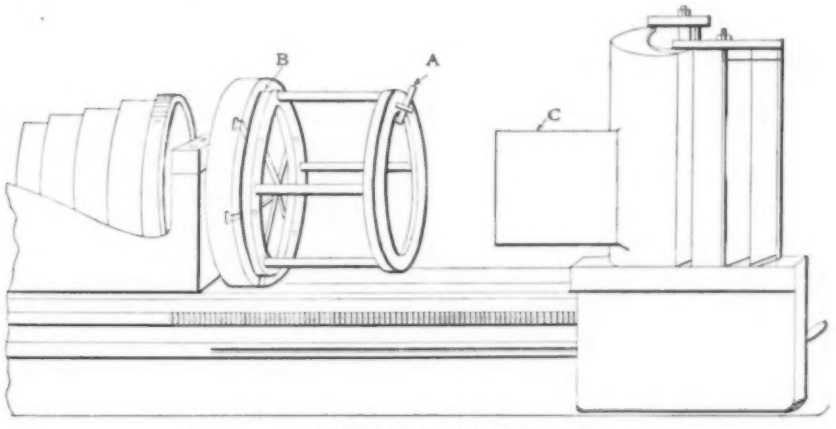
gaged on the drill-press spindle. Fig. 1 shows section view, Fig. 2 an end view, and Fig. 3 a side elevation. *B*, Fig. 1, is the only piece made of tool steel. The lock nut *C*, and the sleeve *D*, are machine steel. The lock nut is nurled so as to need no wrench in adjusting the tool for different depths.

CLAUDE G. HOLT.

A Large Hollow-milling Job

I have attempted to show a job I saw done in a small shop where the largest lathe could not swing the cast-steel trunnion pins *C* cast in one piece. *B* is the rig bolted to the face plate; *A* is the tool.

A new man coming into the shop was



A LARGE HOLLOW MILLING JOB

noticed calipering with a pair of micrometers, as one would with an ordinary caliper; after getting them to fit the shaft, he was seen to pull out of his pocket a two-foot boxwood rule and hold the micrometers against it.

W. S.

Repairing a Broken Shaft at Sea

The good ship "Wacht een Beetje" was a single-screw passenger boat with a speed of 15 knots. She had a triple-expansion engine of about 6000 indicated horsepower, with 160 pounds boiler pressure, a stroke of 4 feet 6 inches, and made about 82 revolutions per minute. She had 21 fires under forced draft, and when running for a tide could be forced up to 16 knots. Her line of shafting was 16 inches diameter and the low-pressure slide-valve gear (of the Stephenson type) hung over the forward end of the thrust shaft, on to which the eccentric pulleys were keyed, just abaft the flanged coupling.

The engine-room staff consisted of 12 engineers, including the two electricians who looked after refrigerators as well as the dynamos. The chief, of course, kept no watch; the first assistant ran the 4 to 8, the second assistant the 12 to 4, and the third assistant the 8 to 12. Then came three juniors, one on each watch, and lower down the scale the three assistants, also one on each watch. To this long-suffering body I had the honor to belong.

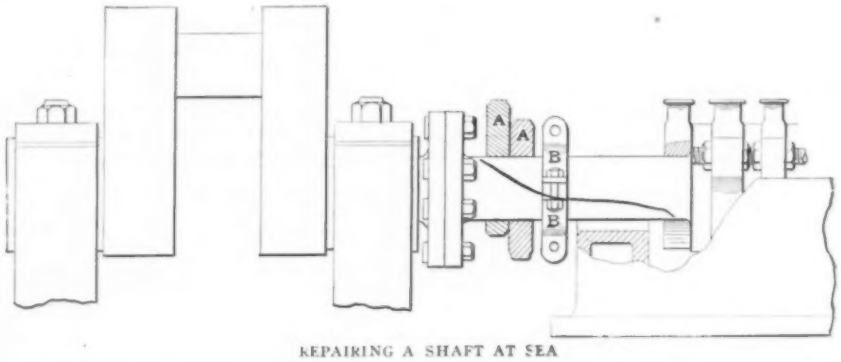
I was on the 12 to 4 watch and one afternoon, when we had still 1400 miles to go to New York, we were relieved at 4 p.m. by the first assistant's watch, who came below, felt around, noted pressures, vacuum, etc., while the seniors relieved one another in the boiler room. "Mouldy," the 4 to 8 junior, took over the engine room from our junior and we joined the second assistant in the mess room for a little refreshment. We hadn't been seated many minutes when "Mouldy" suddenly blew in and accused us of having had the forward thrust bearing hot, of cooling it down with sea water to pass muster and saying nothing about it. This of course we denied, and after a little animated conversation we all filed below to view the affected part, which certainly was warm and had the Atlantic playing over it in a vain endeavor to cool it off again. "Chappy," our senior, summoned the first assistant from the fire room to hold a consultation about it, as it would not cool down again; we then slackened back the cap and put packing pieces under it to allow more air to circulate around the shaft; and, as we could do no more just then, we adjourned again.

At 8 p.m., at the relief of the watch, another consultation was held, as the bearing was getting steadily warmer and water was pouring over it in good style, with little effect. As it was about time for the chief to take his constitutional stroll around, they decided to stop and have a thorough examination. So word was sent to the chief, while "stop" was rung up to the officer on the bridge. The first assistant had just got the stop valve closed, when the chief appeared on the scene, and, with an unprintable inquiry as to what they thought they were doing, rushed over and yanked the stop valve full open again. This put the finishing touch to the warm bearing, for a pyrotechnic display took place in the vicinity of the low-pressure eccentric sheaves, and the engine had to be stopped for good this time and all hands had to turn to and take everything adrift for examination.

The sheaves *A* came off quite easily, but in fragments, as the shaft had a long diagonal split in it, into which you could poke a piece of tin for 13 inches, which extended from the forward thrust collar through the bearing and beyond the place where the eccentrics were keyed. The opening out of the shaft, owing to the sudden strain, had burst them. We took the front eccentric rod off and slung the back one up out of the way without disconnecting from the valve quadrant, removed the low-pressure slide valve and secured it to the gratings around the tops. We then took the brass bearing out of the thrust carriage and proceeded to fit keys into the crack. The idea was to bind it up tight with wire rope, and the keys were to keep it from closing and working in the rope. The turning gear was of course put in and two mast clamps *B*, with eyes for carrying the derricks, were put around the shaft outside the bearing; but, being too large in diameter, they had to have packing plates put in with them to clamp the shaft sufficiently to withstand the pull of the wire rope which was secured to the eyes. The wire was then led at right angles to the shaft across the platform and around a stanchion to give it tension; then forward with a turn round another stanchion to give it more tension, and a sailor hung on to the end to see that it got good tension all the way. The turning gear was started and the shaft wound the rope around itself all along to the thrust collar and back again to the clamp, where it was securely fastened. The thrust carriage was found to be split and hard to have holes bored, a strong stay put through it, the crack caulked, etc. We were then ready for a trial spin.

Of course we had to run her as a compound engine, allowing the steam to blow right through the low-pressure cylinder to the condenser; but we gradually worked her up to 40 revolutions per minute and then took up our usual watches and kept a sharp lookout on a center-punch mark on the shaft at the end of the crack to see that it did not extend. The low-pressure engine was left to run idle to help balance the working parts; the next day we increased the revolutions to 50 per minute and came along to New York without further mishap, but about four days overdue. Now if that shaft had been examined, as the first assistant intended, it would probably have been discovered with a slight rupture, but sufficiently strong to have run at a reduced speed; but the sudden strain of stopping, and then turning on a full head of steam, twisted her almost in two, caused us a lot of work and anxiety for fear she would give out again, and disabled her for maneuvering for pilot and docking purposes. When the wire rope was taken off, the keys were still found to be hard and fast in the crack, which showed that she had not been working; but the strands of the rope had left their mark on the shaft, indicating a pretty high tension on the rope.

J. MACK.



REPAIRING A SHAFT AT SEA

Another Way to Make a Fly-wheel

The method described by Jabez Nall, at page 56, part 1, is a very good one, but to my mind it has one objection, that is, the jointing of the arms in the center. A little more expense incurred in the pattern shop, which will be amply repaid in the foundry, will make a better job of the casting.

I used to make fly-wheels the same way as J. N. until I got a manager who was particular about the appearance of a casting. The last core box I made on that principle was for a wheel about 48 inches diameter. The cores were made all right, but the molder did not take enough care to set the top cores even on top of the bottom ones. The consequence was an overlapping at the center of the arms. Of course this was not the fault of the pattern shop, but I had to stand the racket, the manager declaring that we in the pattern shop should make it impossible for the molder to put anything in the sand in any other position than where it is intended to go. This is rather a tall order,

but although it is difficult at times and in some cases impossible to carry out, it is nevertheless a good end to keep in view. Castings which are made wrong through neglect of this precaution may not be directly blamed on to the patternmaker, still it requires a lot of explanation which is not always satisfactory to the powers that be.

The way we make these "rush" fly-wheels now may interest some of your readers. It is more satisfactory and although, as previously stated, it means more work in the pattern shop, this is amply repaid in the foundry. Only six cores and core irons are required, and only six joints to make good in place of twelve. The arms come out without fins or overlapping, which means so much less cleaning.

Figs. 1 and 2 will help to show how this is done. The core box is made the full depth; the complete arm with part of boss and rim is left loose, so that when the core is taken from the box the boss and arm can be drawn one way, and the rim the other way. The sweep in this case is made the full depth to suit the cores. Fig. 3 shows the core set in the mold.

The same principle can be applied to the making of grooved wheels, but in place of having the sweep to form the outside, a plain board is used to make a level bed and a core box with the grooves worked in to form the outside of the rim. I am aware that in many instances the grooves are arranged to be put in by the molder by means of the sweep, but where not more than two or three grooves are required it is a question if it pays to do so. Like a great many more jobs done by the patternmaker, the method is very often settled according to circumstances.

The making of the core box is not an expensive job if the back piece is made with the grooves jointed through the center, so that they can be worked on a spindle wood molding machine. Another and still cheaper way of making the box is shown by Fig. 4. The outside diameter is made the bottom of the box, and the grooves formed on top by the strickle.

Another point about the making of these core boxes which is well worth considering is to have pieces put in on each side as shown at *a a*, Figs. 1 and 2. These leave a space between the cores, and if made as large as possible consistent with safety, it is obvious that less time will be required to dry the core; and when being set in the mold, they will not need as much fitting together, especially in the case of cores made for the larger sized wheels.

M. PETERS.

Horwich, England.

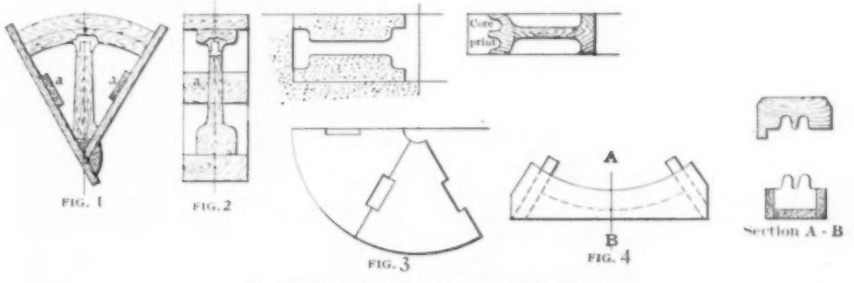
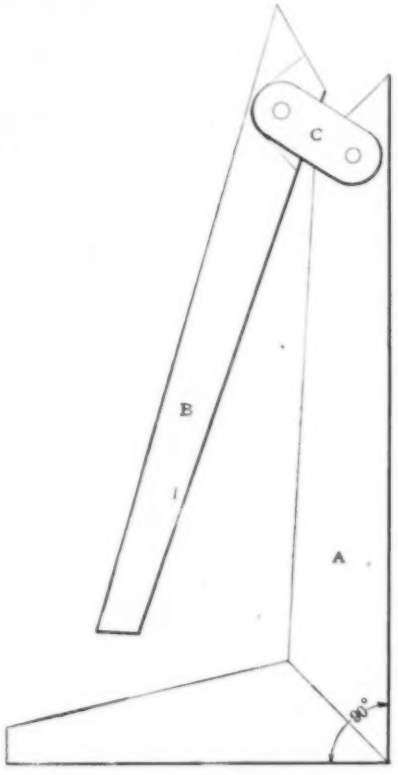


FIG. 1 FIG. 2 FIG. 3 FIG. 4

ANOTHER WAY TO MAKE A FLY-WHEEL

An Adjustable Triangle

Mr. Barber's adjustable triangle at page 637, seems a serviceable tool for the purpose. There is, however, a much simpler arrangement in use here, as shown in the accompanying cut.



AN ADJUSTABLE TRIANGLE

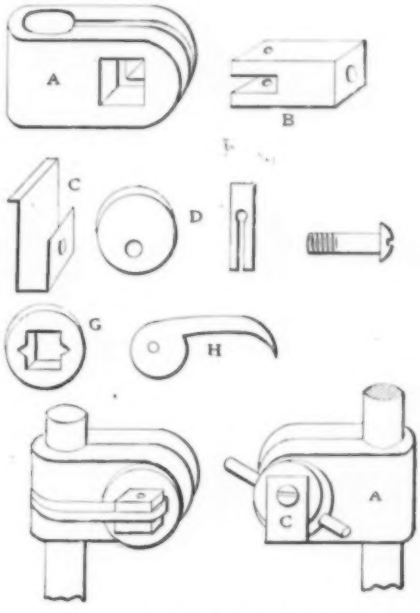
These triangles are made of suitable hard wood ⅛ inch thick. *A* is the fixed member and *B* the adjustable one. The joint at *C* is stiff enough to maintain adjustment with ordinary handling. The hinge is composed of two flat brass plates 1/32 inch thick let in flush with both sides of the triangle and riveted in place. The member *B* is cut away, as shown, to allow adjustment through 90 degrees. As they are flat on both sides, they can be used either side up and with either the short or long side of *A* against the *T* square. This gives a full range of action, and the utility will be appreciated by those who have any amount of odd-angle drawing to do.

H——, England. MERRIMAC.

A Quick-action Nut for Surface Gage

The original surface-gage nut of this drawing has been used by me since the summer of 1904, and has proved satisfactory. Some of the readers may like a quick-action nut on the same order.

The clamp *A*, which is the same as a common nut (in which a 5/16-inch stem is used), is 1 inch long, 9/16 inch wide and ½ inch thick. The square hole in the split end is ⅜ inch. The small needle clamp, which is shown at *D* and *E*, is 9/16 inch in diameter, 5/16 inch thick and drilled 3/16 inch to receive the needle. The piece *B* is ⅜ inch square by ⅞ inch long and slotted at one end ⅜ inch deep and ⅛ inch wide. It is drilled and tapped 3/16 inch. The washer *G* is 9/16 inch in diameter, ⅛ inch thick and case-hardened, as is eccentric *H*.



QUICK ACTING NUT FOR SURFACE GAGE

The clamp *D* is placed in *C* so holes correspond, and screw *F* is passed through *C* and *D* and screwed into the tapped hole in the end of *B*. *B* is placed in the square hole in *A*, the case-hardened washer *G* is slipped over the slotted end and the eccentric *H* is pinned in the slot of *C*. This nut is then put on the stem and adjusted by the screw *F* until it is right tension for the operator.

The drawings at the bottom show both sides of the nut as it should be when finished.

F. JAMES.

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The Advancing South

Our title is taken from a recent number of *The World's Work*, an issue dealing with the growth of the Southern States in the last few years, their needs, their resources and their possibilities. While the greatest advances have been made in agricultural pursuits, much has been done in the way of manufactures; and the great undeveloped natural resources of our country, which lie at the foundation of factory development, are in the fifteen States usually comprehended in the term Southern in very great measure.

Of these gifts of nature, mineral wealth, timber wealth and water power are the three greatest factors. Quoting from an article in the magazine referred to, compiled from official statistics:

"About one-seventh of the mineral production of the entire country comes from the Southern States. Of bituminous coal, the most valuable mineral, the South produces one-fourth and of iron one-ninth. Its total coal resources amount to nearly 600,000,000,000 tons, or more than one-fourth of our estimated coal reserves. The showing in iron-ore reserve is quite as good; a safe minimum is over 3,000,000,000 tons, or nearly one-third of the nation's total. Of workable iron ore the South contains one and one-half times as much as the famous Lake Superior district.

"On a basis of value of product, the South furnishes more than two-sevenths of our oil and more than one-sixth of our gas.

"The finest hard wood left in the country and the chief source of present supply is found in the South, mainly in two bodies, the Appalachian forests and the hard woods of Arkansas and the bordering States to the south, west and north. A careful estimate of present resources gives the area of standing forests as 296,000,000 acres, or seven-tenths of the forested area of the United States."

The rivers of the South are numerous, as a glance at a map will show, and this means possibilities for water power. Quoting on this point, "Good information now points to a possible total of 3,000,000 horse-power." Only a fraction of this has as yet been developed, but methods of electrical transmission should in time make it all available. Coupled with these great resources is a geographical position which gives a longer working day without need of artificial lighting, and a temperature needing less artificial heating than in the North. This means a lessened expense in factory building and equipment and a reduced cost of operation for these two items.

Two other local factors enter into factory development besides natural resources, namely, transportation facilities and labor. The transportation question can be briefly passed by calling attention to the long seaboard, the many navigable rivers, of which of course the Mississippi is the greatest, and to the rapid extending of the railway lines. During last year about 45 per cent. of the new railroad actually built in the United States was in the South.

The labor situation is different; it is the weakest of the industrial elements. More is needed of an intelligent, industrious kind. The facilities for education are improving year by year, and this is having an influence upon the native labor, both white and black; yet more is needed. Several States are making an effort to encourage desirable immigration and are even sending commissioners to Europe for that purpose. In the industrial field there is a demand for men with a constructive instinct, with the ability to do. The land needs the mechanic, the engineer, the man of affairs, and for such there must be a rich reward.

A section of our great country which has one-fourth of the coal supply, one-third of the iron supply, seven-tenths of the timber supply, abundant water power, a favored geographical position, of which nearness to the Panama canal is only one feature, and good and improving transportation facilities, must surely grow and develop tremendously along industrial lines during the period of the next generation.

New Publications

TARIFFS ON MACHINERY, MACHINE TOOLS AND VEHICLES. 75 6x9-inch pages. The Government Printing Office, Washington.

The compilation of tariff rates on machinery, as made by the Department of Commerce and Labor and published in Daily Trade and Consular Reports, from time to time, has already been noticed in these columns. The tables have now been collected together and republished in this pamphlet, which all exporters of machinery will find of large use.

Of 49 German smelting works 32 have gas engines at work and 9 have such engines ordered. The largest aggregate power at a single works amounts to 35,000 horse-power. Sixteen works possess over 10,000 horse-power, and 27 works have over 5000 horse-power in actual work. In March, 1906, sixteen collieries had 35 gas engines at work or being erected, of an aggregate horse-power of 30,300. Of these 24 engines of 15,600 brake horse-power are at work, all for the production of electricity. At present 29 firms in Germany build large gas engines, and of these 21 build double-acting four-cycle and 5 firms build two-cycle engines, while 3 firms build both systems.—*The Engineer* (London).

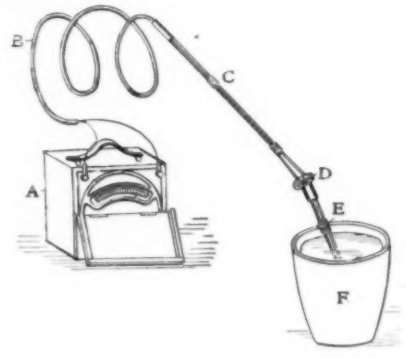
New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

A Portable Thermo-electric Pyrometer for Taking Temperatures of Molten Metals

The determination of high temperatures used in industrial processes is a matter of increasing importance and one which has been frequently mentioned in our columns. One field for such determinations is in connection with the use of molten metals and alloys for casting and the like.



A PORTABLE THERMO-ELECTRIC PYROMETER

For this purpose a portable indicating instrument has been developed by Wm. H. Bristol, 45 Vesey street, New York City.

The pyrometer outfit consists of the instrument and a thermo-electric couple designed for this particular service. The two elements of the couple are disconnected and are not insulated. When their tips are immersed a short distance in a molten metal, electrical connection is made through the metal and the reading of the instrument is the same as if the elements were joined.

The accompanying illustration shows the arrangement of the instrument and elements applied to a crucible of molten metal. At *A* is shown the instrument with its leads *B*. At *F* is the crucible containing the couple *E* with its tips immersed in the fluid metal. Connecting the couple with the instrument leads are the separable junctions *D* and the couple extension *C*.

The advantage of the bare tips of the couple is that they reach the temperature of the bath into which they are plunged almost instantaneously, and thus the time-lag error is practically eliminated. In use a temperature determination can be made in from two to three seconds.

When the tip of the couple becomes worn, a fresh portion is exposed and the reading is not altered. The separable junction *D* is provided so that new tips can be easily connected when needed. These instruments are in use for determining the temperatures of molten cast iron, copper, aluminum, brass, bronze and other alloys.

[A description and discussion of the instrument itself may be found on pages 201 and 629, Volume 29, part 1.—Ed.]

A Large Broaching Machine and Its Work

The engraving shows the No. 4 broaching machine, recently built by the Lapointe Machine Tool Company, Hudson, Mass. This has the same operating mechanism as the smaller machines, but is somewhat different in design and is interesting on account of its size and capacity of doing heavy work.

The driving screw which pulls the cutter-bars is 3½ inches diameter 1 inch pitch, with a traveling range of 70 inches. This screw is driven by a phosphor bronze nut 13 inches long, located between the driving gear and the friction pulley. The nut is idle, excepting when engaged in the driving gear by means of a clutch which slides over it, and operated by the handle which is shown on the machine.

The engagement of this clutch to the driving gear is by means of four driving pins, two on the clutch and two on the hub of the gear, so that sliding the clutch brings its pin in contact with the pins in the hub of the driving gear and makes a positive drive. This draws the screw through the nut until the operating handle is pushed into the neutral notch located in the center of dial, or automatically knocked off by means of the stop pin.

To return the screw for a new cut, the operating lever is thrown backward by pushing the clutch into the friction pulley, which has sufficient power to return the screw at high speed. This movement can be controlled or stopped either by pulling the operating handle back into the neutral notch or letting the stop pin automatically knock off the friction. The automatic movement to operate the clutch is obtained by means of a sliding rod on the opposite side of the machine, which cannot be seen on the illustration. The stop

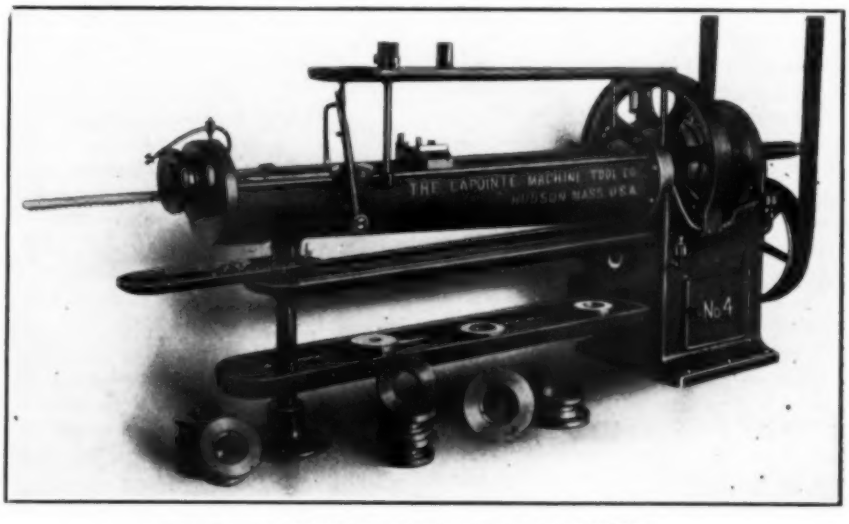


FIG. 1. A BROACHING MACHINE FOR LARGE WORK

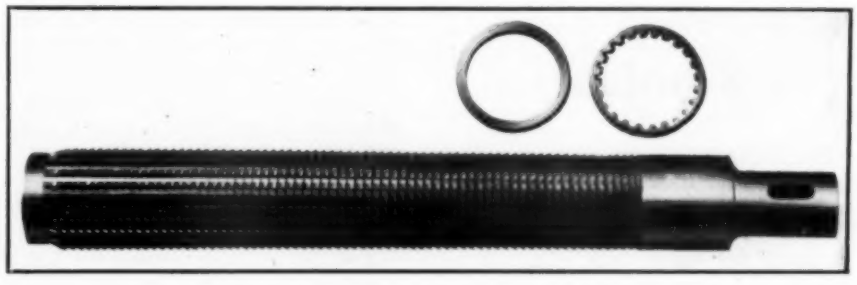


FIG. 2. BROACH FOR 3-INCH INTERNAL GEARS AND ITS WORK

collar, as shown on the machine, is adjusted on the sliding rod at any position desired to operate the stop. When the stop pin comes in contact with this collar it slides the rod, moves the fork engaged in the sliding clutch sufficiently to throw off the engaging of either clutch from the pin or from the friction pulley.

The driving gear is 24 inches in diameter, and is driven by a pinion on the driving shaft. The ratio of the gearing is 10 to 1. The sliding head fastened to the end of the screw, has a vertical sliding block with provisions for connecting the broaches to it.

For cutting a keyway in a hole, the cutter bar or broach is screwed into the sliding head, and made fast by means of a clamp collar, preventing it from twisting. The cutter bar slides into a work bushing on which the work to be splined is mounted. For cutting keyways it is not necessary to dismount the cutter-bar or broach from the machine. Merely run the tool out of the machine to the extreme length which is limited by the automatic stop of the machine. This allows the work to be passed or slipped on to the work bushing, and requiring no fastening any more than the pressure which is applied by pulling the tool through.

For broaching square or other shaped holes it is necessary to drill a hole in the piece the size of the neck of the broach to allow it to pass through, and then connect to the machine to be pulled through. In this case it is necessary to disengage the broach from the machine in order to put the piece on the broach. The connection can be made very quickly by means of a key fitted in a loose manner dropping through the pull bushing and the broach.

In some cases one broach is sufficient to produce a square hole, and in other cases when the work is long it requires two or more broaches. This, of course, depends on the size and length of the piece to be broached.

When doing short work two or more pieces can be done at the same time, depending on their length.

A very interesting broaching job recently done on this machine is shown in Fig. 2, which illustrates the broach, the gear blank, and the finished gear. This gear was about 3⅛ inches internal diameter, had 24 teeth with a 20-degree pressure angle, and was cut at one passage of a 24-inch broach. The time was one minute.

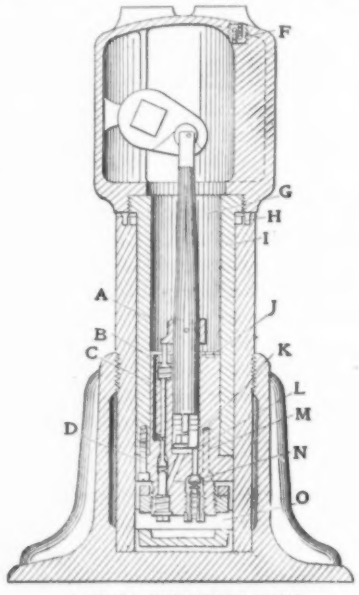
This machine has a capacity to cut a 3-inch square hole 10 inches long.

A New Hydraulic Jack

We illustrate in cross-section a hydraulic jack of the inside pump type, such as is being quite extensively used by the United States and other governments for ship-yard and similar uses.

This jack consists essentially of two hollow concentric steel cylinders machined to sliding contact with each other. The outer cylinder is fixed in a steel base and the joint packed with a copper cup to withstand great pressure. The inner cylinder is closed at the top by the head and at the bottom by the pump block, thus making a reservoir *G*, in which the filling liquid is held. The pump block derives its name from the small pump contained therein and connected through the piston rod to the lever outside. Movement of the lever forces the liquid through suitable valves into the space between the lower end of the pump block, and the bottom of the outer cylinder, thus pushing the base and head apart with a gradual but absolutely positive movement.

In older types of hydraulic jacks the filling hole contained a filed groove to



A NEW HYDRAULIC JACK

allow the air to enter and escape as the ram was raised and lowered, liquid was bound to escape also when the jack was resting in a horizontal position. In this jack the filling device consists of a plug with two valves, one opening inwardly and the other outwardly, both being held to their seats by springs of sufficient stiffness to prevent the liquid escaping as the jack is laid down, but sufficiently elastic to allow the entrance and escape of air to and from the cistern as the ram is worked up and down.

In this jack the cup packing is of copper accurately turned to fit the bore of the cylinder. The inside of the cup is turned to a slight taper, and after being placed in a position a plug or packing ring having the same taper is forced into it, swaging the sides of the cup against the cylinder walls and making a tight, permanent joint which need never be touched.

Another source of trouble existing in hydraulic jacks was due to dust, metal chips, or sand lodging on the ram when it was run out. If these were not removed on lowering they were carried down between the ram and cylinder, cutting grooves in both and doing irreparable damage to the jack. This trouble is prevented in the present jack by placing a wiper *H* around the ram *I* at the top of the cylinder. The wiper is saturated with oil and, in addition to wiping off any dirt from the ram as it passes down into the cylinder, lubricates the sliding surfaces, keeping them smooth and unscored.

The filling liquid also may contain dirt and grit, and it is of the utmost importance that the liquid be strained before it leaves the cistern, on its way to the pump. Otherwise, the particles would soon prevent the proper seating of the valves, ruin the contact surfaces and otherwise interfere with the successful working of the jack. Trouble of this nature is prevented by a fine screen on top of the pump block, through which all the liquid must pass before reaching any delicate working parts and surfaces. It may be noted from the cross-section that the suction valve is so located that the liquid may be taken from the extreme side of the bore of the ram. This permits the use of the greatest possible amount of liquid, a very important point when using the jack in a horizontal position, since the limit of the stroke depends upon the quantity of liquid which can be forced into the cylinder.

The path of the liquid from the cistern to the main cylinder is as follows: When the pump plunger is raised, the suction valve *D* is drawn from its seat and oil passes through the filter screen *J*, through the passage shown in the extreme left of the pump block *M*, past the suction valve and into the pump cylinder *L*. When the plunger *K* is lowered, the suction valve closes and the liquid forces the discharge valve *N* open, passes by it and through the openings in the side of the valve cap into the cylinder *O*, thus raising the ram. The illustration shows the plunger at the lower end of the normal stroke in which position the end of the pump rod touches the discharge valve stem and at the same time the tripping lug forces the tripping rod *C* into contact with the suction valve stem. A slight additional length of stroke trips the jack, opens both these valves and allows the liquid to pass back to the cistern by the same channels through which it came. A lug on the operating lever coming in contact with a stop on the outside of the ram head prevents the stroke from being prolonged so far that the end of the plunger would touch the valve openings. The speed at which the jack may be lowered in this way is regulated by the pressure which the operator exerts on the lever.

A valve *B* is provided on the upper end of the tripping rod which prevents the pump taking air when the level of the liquid has fallen below the tripping rod.

The tripping mechanism is positive and under the direct control of the operator. It does not depend upon springs and cannot fail to act. In starting, the lever is turned with the lug pointing up, raised

slightly to remove the pressure in the pump cylinder, and to allow the suction valve to fall from its seat, then lowered slowly to allow the liquid to flow back from the pump cylinder to the reservoir.

For convenience in attention, both the suction and discharge valves are located in the end of the pump block so that by taking the ram out and unscrewing the caps which cover them they are immediately exposed. The discharge valve spring is protected by a casing and operates through a plunger which holds the valve normally to its seat. The casing protects the spring from the violent current of the liquid which in other makes tends to jam the unprotected spring out of shape.

The cylinder and ram are forged and machined from solid high carbon, open-hearth bar steel, and the sliding surfaces contain no welds or seams. The head and base are crucible steel castings and the pump block is milled from a solid bar of Tobin bronze. The valves are made from phosphor bronze and are compressed to render them durable. The valve caps, the discharge valve plunger, and discharge valve spring are also of bronze, making a non-corrosive combination which will not cause trouble from the use of an improper filling liquid.

This jack is made by the Joyce-Cridland Company, Dayton, O.

Gas-engine Progress

A correspondent in *Engineering* states that a gas-engine station in course of construction at Madrid will have a capacity of 12,000 horse-power, in six units of 2000 horse-power each, and will be in full work by the end of the year. A plant of 48,000 horse-power is in course of erection at the Deutscher Kaiser steel works, and will consist of twenty-four engines of 2000 horse-power each. The United States Steel Corporation in America has placed large orders during the past year for gas engines of 3000 horse-power and upward, and the town of Scheveningen has been for many years past running exclusively by large gas engines. In conclusion the writer says: "I have had occasion to pay rather frequent visits to Germany during the past few years, and every time I have found gas-engine houses being extended and larger units put down. All types of engines enjoy their share of patronage. The Nürnberg, Cockerill, Ehrhardt and Sehmer, Deutz, and Oechelhauser types may be found running in the same power houses, and the users of the large gas engines on the continent seem to have passed through and to a great extent forgotten their early troubles."

Cost Accounts

By H. F. J. Porter

By an oversight we failed to state that the article under the above title, published on page 918, was a paper read at the recent Philadelphia meeting of the American Foundrymen's Association.

Obituary

Ellicott McConnell, mechanical engineer, died at Philadelphia, June 28, 33 years of age. After graduating from Cornell University he served four years' apprenticeship at the Baldwin locomotive works, and during the Spanish-American war served as engineer on a United States gunboat.

Business Items

General Engineering Company, 90 West street, New York, wants catalogs of machinery equipment and supplies for a general machine shop, foundry and boiler shop.

The Lumen Bearing Company, of Buffalo, N. Y., is erecting a two-story building to be used for the storage and manufacturing of wooden patterns and as a carpenter shop. This addition will greatly facilitate the company's work and gives them storage capacity for 50,000 patterns of the ordinary run of brass-foundry work.

The works of Brown & Sharpe Manufacturing Company, Providence, R. I., will be closed from August 2 to 12, inclusive for the annual vacation and repairs. During the vacation the offices will be open as usual and orders for machine tools, machinists' tools and measuring tools will receive the same attention as at other periods of the year.

The Department of Mechanical Engineering practice of the Carnegie technical schools is starting a catalog file, and requests manufacturers of machinery to send their catalogs in care of Professor Trinks, Carnegie Technical Schools, Pittsburg, Penn. Complete information is desired on all lines of mechanical work from boilers and engines to automatic and special machinery.

George F. Adams and James R. Downs, who have been connected with the Westinghouse Electric and Manufacturing Company for the past ten years, have resigned from the Cleveland selling organization and have opened an office in the New England building, Cleveland, Ohio, under the style of Adams & Downs. They have an agreement with the Burke Electric Company, Erie, Pa., as selling representatives to handle their complete line of alternating- and direct-current dynamos and motors.

Trade Catalogs

The "OK" Tool Holder Company, Shelton, Conn. Catalog of tool holders and tools for lathes, planers, shapers, boring mills, etc. Illustrated, 30 pages, 5x7½ inches, paper.

The Dayton Pneumatic Tool Company, Dayton, Ohio. Catalog describing pneumatic hammers, drills, hoists, air compressors, etc. Illustrated, 48 pages, 6¼x6¼ inches, paper.

Jacobson Machine Manufacturing Company, Warren, Penn. Bulletin "C," describing the Jacobson gas and gasolene engine for stationary and portable purposes. Illustrated, 16 pages, 6x9 inches.

Waterbury Farrel Foundry and Machine Company, Waterbury, Conn. Catalog, Section H, descriptive of hydraulic presses, accumulators, pumps, etc. Illustrated, 152 pages, 6x9 inches, paper.

Manufacturers

The Florida Iron and Wood Works, Apopka, Fla., will enlarge its plant.

Stuber & Kuck, Peoria, Ill., manufacturers of tinware, are erecting a new plant.

The Weber-Bussell Cannery Company, of Seattle, Wash., will erect a $25,000 cannery in Sumner.

The Ralston Steel Car Company is erecting a new planing mill at its plant in East Columbus, Ohio.

It is said the American Thread Company will build a new mill at its plant in Willimantic, Conn.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, Amer. Machinist.

We desire a few more machines or specialties to manufacture. Box 423, Troy, N. Y.

Machines designed and built. Walter S. McKinney, M. E., Broadway, Flushing, N. Y.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

High-grade gray iron machinery castings. Write for quotations. Phœnix Iron Works Company, Meadville, Pa.

Special machinery built to order; let us estimate on your work. Capital Foundry and Machine Company, Frankfort, Ky.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

We will do your manufacturing for you; well established and equipped foundry and machine shop. Emmert Mfg. Co., Waynesboro, Penn.

Well established concern will pay royalty for several good patented machines or tools to manufacture. Emmert Mfg. Co., Waynesboro, Penn.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Men who operate grinding machines should read H. Darbyshire's "Precision Grinding," a $2 book that's worth ten times that money to you. Hill Pub. Co., 505 Pearl St., New York.

Drawings, checking and detailing done quickly and accurately by technical graduates with long experience in all kinds of a drafting and design. Address Box 173, Am. M.

Radiators and boilers, reliable Lyon house, familiar with all heating apparatus, desires representation for France of radiators, boilers and metallurgy or implements. Address No. 647 Agence Fournier, Lyon, France.

Draftsmen; Clifford's book of alphabets, for titles, sign painting or show cards, valuable to every designer; limited number only; price 25 cents; write now. C. W. Clifford, 643 Belmont ave., Philadelphia, Pa.

A well equipped machine shop and foundry desires to add to its output by the manufacture of articles of brass and iron which would find a ready sale in the South; correspondence invited. Box 122, Am. Mach.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Engineer and machinist, member A. S. M. E., formerly chief engineer and superintendent of large steam pump works, desires to represent a firm in New York as engineer and salesman; available September. Address "Expert," AMERICAN MACHINIST.

Designer of special manufacturing devices, tools, dies, jigs and fixtures, special machines, etc.; tell me your wants, I can help you; thoroughly up to date; your correspondence solicited. H. A. Everts, M. E., 55 William St., East Orange, New Jersey.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th Street.

Advice; mechanical, practical and technical; tell me your needs I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

Arrange with us to do your manufacturing; we are thoroughly equipped for all classes of machine work, including screw machine and punch parts, tools, jigs, etc.; we also design and build to order special and experimental machinery. Forest City Specialty Manufacturing Co., Rockford, Illinois.

Planer hands—C. Ashley, a planer hand, has written a book "Planer Kinks," for practical planer men and every planer hand should get it; $1 postpaid. Hill Pub. Co., 505 Pearl St., New York.

I have a machine shop (Pittsburg) newly equipped for light and medium weight machine, tool and die work; wish skilful foreman machinist and toolmaker with some good inventions to join me; my business is prosperous; good chance to get into business and make money. Address B. F. Bain, Pittsburg, Pa.

We have a special proposition for a few bright, energetic mechanics, such as foremen, draftsmen or machinists in different sections of the country; no canvassing or selling of any kind, and, while not interfering with your regular work, pays well for the time taken; we want only practical men who can be depended on to give the little time required each week; further particulars on application. Box 102, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Foreman machinist wants a position; had large experience on engine work and building all kinds of machinery. Address "Competent," AMERICAN MACHINIST.

Superintendent, aged 42 wishes change; 12 years' executive experience, experimental, steam specialties, interchangeable manufacturing, close tool work, labor saving devices; Bridgeport or Connecticut preferred. Box 177, AMERICAN MACHINIST.

ILLINOIS

A capable designer familiar with machine tools, special machinery for manufacturing purposes, presses, dies, jigs and fixtures, etc., wants responsible position either at designing or in charge. Box 175, AMER. MACH.

Superintendent, practical machinist and toolmaker; wide experience on interchangeable work, special machinery and metal specialties; excellent manager of men; can handle big proposition and produce results; high recommendations. Address Box 143, AM. M.

MASSACHUSETTS

Manager or superintendent—practical, wide and successful experience, with good executive ability—desires correspondence from parties in need of an up-to-date, energetic and loyal man; all correspondence strictly confidential. Address Box 114, AMERICAN MACHINIST.

NEW JERSEY

General foreman, excellent toolmaker and machinist, designer of labor-saving devices, open for engagement. Box 158, AM. MACH.

Wanted—Position as factory manager or superintendent by one thoroughly familiar with the design and manufacture of gas, gasolene and producer gas engines and producers; capable of producing the best results. Address "Reliable," AMERICAN MACHINIST.

NEW YORK

Toolroom foreman or machine shop; practical man with long years experience wishes to change present position. "J. N.," AM. M.

Draftsman, 5½ years' experience, 2 years shop work, third year student of mechanical engineering at Cooper Union. Box 180, AMERICAN MACHINIST.

Fine toolmaker; 20 years' experience in automobile, rifle, cash register, etc., want situation by 15th of this month in or outside New York. Box 182, AMERICAN MACHINIST.

Superintendent and master mechanic of large experience, is open for engagement; technical education; small and medium interchangeable machinery, general manufacturing, gas engines or automobiles; excellent references. Box 152, AMERICAN MACHINIST.

Wanted—Position by credit and collection manager, experienced in handling large transactions, domestic and foreign, involving closest scrutiny of conditions and contracts; a corporation accountant of ability; no small position considered. Address "Permanent," care AMERICAN MACHINIST.

Superintendent desiring change solicits correspondence from machine tool concerns desiring the services of a practical mechanic who can organize a shop so as to produce the highest class of work at lowest cost; unquestionable references as to ability and character. Box 166, AMERICAN MACHINIST.

Superintendent or general foreman, of wide experience, executive ability, good character and a practical mechanic with "M. E." knowledge acquired; designer and perfector of machines, tools, devices, etc.; employed but wishes change of position, New York City or vicinity. Address Box 181, AMER. MACH.

OHIO

Wanted—To represent some reliable concern in Cincinnati territory by young man; technical and ten years practical experience in machinery line. Box 174, AMER. MACH.

PENNSYLVANIA

Position as superintendent, experienced in high-grade work, good executive; West preferred. Box 179, AMERICAN MACHINIST.

Works manager; age 34; married; now employed; first-class references; reasons for changing at interview. Box 127, AM. MACH.

Engineer experienced in plant construction and design of special machinery, desires position with concern considering improvements in manufacture. Box 178, AMER. MACH.

Factory executive, engineer, manager, superintendent, energetic, successful, experienced in industrial layout and organization for maximum production; member A. S. M. E. Box 141, AMERICAN MACHINIST.

Experienced woman invites correspondence from manufacturers of machine tools, or in any mechanical line, with a view to position as publicity manager; thoroughly competent to handle printing, illustrating, and the preparation of copy. Box 103, AMER. MACHINIST.

VERMONT

Advertiser will be open for engagement as works manager or mechanical engineer on September 1. Address Box 170, AM. MACH.

WISCONSIN

Molder, 34 years of age, 20 years' experience in all classes of work, desires position as foreman or charge hand. Box 146, AM. M.

Mechanical engineer, 4 years' experience in steam turbines, gas engines, general machinery, also good shop experience, wants to change. Address Box 157, AMER. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

ILLINOIS

Wanted—Thoroughly experienced engineer as chief draftsman for factory employing 500 men and 25 draftsmen in the manufacture of automatic machinery; excellent opportunity for man of exceptional ability and experience. Box 147, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Man thoroughly familiar with the manufacture and assembling of small machine parts to act in the manufacturing department as assistant to the superintendent. Boston Gear Works, Norfolk Downs, Mass.

MINNESOTA

Wanted—First-class machinists on lathes, planers, floor and vise work; non union men only; yearly contracts at 30c. and 40c. an hour. Diamond Iron Works, Minneapolis, Minn.

Instructor in pattern work and carpentry; must be a first-class pattern maker; salary $1000 for 10 months; summer school if desired $150 additional. Address Professor of Mechanical Engineering, University of Minnesota, Minneapolis.

MISSOURI

Wanted—Superintendent for a plant manufacturing large gas engine and gas producer plants; must be thoroughly capable and up-to-date in the manufacture of same and cost reducer; in answering this advertisement, state nationality, age, education, experience, references, and salary expected. Address Box 176, AMERICAN MACHINIST.

Draftsman wanted—Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drawing and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 86, AMERICAN MACHINIST.

NEW JERSEY

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply A. Pond Machine Tool Co., Plainfield, N. J.

Mechanics or brass workers with experience at instrument making preferred; good pay and prospects for advancement to capable men in Newark; state experience, age and wages expected. Box 167, AMER. MACH.

Engineer for machine shop with well established and rapidly growing business; a young, educated, experienced and thoroughly up-to-date man; only those who state age, nationality, experience, references, salary expected, etc., all with full particulars, will be considered. Location about 50 miles from New York. Fine opportunity for the right man. "R. S. K.," AMERICAN MACHINIST.

NEW YORK

Wanted—A manager for a large, well established manufacturing company; state age with full particulars. Box 169, AM. M.

Wanted—Foreman of general machine shop capable of handling at least 150 men; must be a hustler. Maxwell-Briscoe Motor Company, Tarrytown, N. Y.

Wanted—A superintendent for a well established plant having machine shop, foundry and pipe shop; good position for a reliable, progressive man; state age, experience and salary expected. Box 168, AM. M.

Wanted—A young man of practical experience and technical attainments to direct and advise as to all matters appertaining to the production and distribution of steam, electric, air power, heat and light, in a large plant using 11,000 h.p. The results desired are reliable and high efficiency at minimum cost, from present equipment; a good situation, good opportunities and good compensation for the right man. Box 171, AMER. MACHINIST.

OHIO

Wanted—Experienced punch and shear draftsman; state qualifications, age, and salary expected. Box 70, AMER. MACHINIST.

Wanted—Several draftsmen familiar with steam hammer designing; state age, experience, and salary expected. Box 71, AM. M.

Wanted—First-class die and toolmakers on bench and vise work on forming, embossing, and cutting dies; steady employment, first-class wages; excellent conditions; no labor troubles. Box 37, AMERICAN MACHINIST.

Wanted—Machinists and operatives; we are about to remove our machine shops from Kent, Ohio, to Franklin, Pa. Some of our present employees own their homes in Ohio and do not wish to leave them so are seeking other permanent employment here. We therefore offer to qualified persons positions in our present plant from now until about October first and permanent position to those who then move with the plant to Franklin, Pa. To such persons who accept service with us under the present conditions, we will guarantee the best permanent positions when our Franklin plant is in operation, giving the preference even over present residents of Franklin. Franklin is a beautiful little city of 12,000 inhabitants with excellent schools and other facilities. We have no labor troubles in our shops nor have we ever had any. Address communications to C. L. Winey, Works Manager, Kent, Ohio.

PENNSYLVANIA

Wanted—Lathe, planer and boring mill hands. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—First-class hammerman for locomotive frame forging. Apply H. K. Porter Co., 49th Street, Pittsburg, Pa.

Wanted—Foreman for gear cutting department; must have experience; apply with particulars to R. D. Nuttall Co., Pittsburg, Pa.

Molders Wanted—Good pay and steady work for competent and desirable men; open shop; no labor troubles. Address with full details of experience and wages expected. Box 138, AMERICAN MACHINIST.

Wanted—Man about 35 as general foreman, shop employing 200 men, on machine

tools and special machinery; must be familiar with up-to-date methods; give experience, references and salary. "X. X.," AM. MACH.

Wanted—By a new Philadelphia molding machine concern, a young draftsman, one eventually capable of travelling, in interest of the business; state age, experience, references, and salary expected. Reply "U. S. M. M.," care AMERICAN MACHINIST.

Wanted—Technical college graduate as instructor in mechanical engineering, with at least 2 years' drafting room experience, and a good scholastic record in the principles of mechanics; part of duty to assist in summer term work; state minimum salary that would be accepted; send application and references to Professor of Mechanical Engineering, 357 Market street, Bethlehem, Pa.

Superintendent—Wanted a mechanic 35 to 40 in our plant, employing about 50 people, which will be increased to 100; we manufacture small metal goods of wire and sheet metal; applicants must be expert die and tool makers and thoroughly understand the handling of automatic machines; position will pay $1500 to begin, which will be rapidly increased to $2500. Address "Energetic," AMERICAN MACHINIST.

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VIRGINIA

Wanted—Mechanical draftsmen that are thoroughly experienced in making layouts for elevators. Westbrook Elevator Company, Danville, Virginia.

Wanted—Draftsman to make designs, working plans and drawings of special, new centrifugal separator; must be an experienced man. Address, stating qualifications and salary expected, Box 172, AMER. MACH.

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First-class operator for setting up jobs on Cleveland automatic and other make screw machines. Address Box 100, AMER. MACH.

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee.

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Test Indicators. H. A. Lowe, Cleveland, O.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

For sale or will lease to responsible parties modern equipped brass foundry, located in Brooklyn. Address "B. F.," AMER. MACH.

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United States patent 302,032 for sale; cannot manufacture the same on Pacific coast. Address the inventor, 368 Connecticut St., San Francisco, Cal.

For Sale—Ten volume library covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

For Sale—One branch of a well established line of machine tools in the middle west with good foreign and domestic agents and five months' orders ahead. Address "Special," AMERICAN MACHINIST

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Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadephia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction

Electric Controller & Supply Co., Cleveland, O.

Brazing

Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels

Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing

Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Manufacturers Foundry Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.
Keystone Steel Casting Co., Chester, Pa.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.

Centering Machines—*Cont.*

Hill, Clarke & Co., Inc., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor, Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co, New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Woods Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic

Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic

Sturtevant Co., B. F., Hyde Park, Mass.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Slushing

Warren Bros. Co., Boston, Mass.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Ingersoll-Rand Co, New York.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.

Coping Machines—*Cont.*

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts

National Brake & Clutch Co., Boston, Mass.

Corundum

See Grinding Wheels.

Cotters

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Heber & Co., J. R., Brooklyn, N.Y.
Veeder Mfg. Co., Hartford, Ct.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Electric Controller & Supply Co., Cleveland, Ohio.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes,

Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.

Cranes—*Continued.*
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Phila., Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros, Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cu...ng-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Cyclometers
Veeder Mfg. Co., Hartford, Ct.

Diamond, Tools
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, Ohio.
Superior Corundum Wheel Co., Waltham, Mass.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.

Dies, Sub-Press
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Mittineague Paper Co., Mittineague, Mass.
Keuffel & Esser Co., New York.
Soltmann, E. G., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Noyes Mfg. Co., Waynesboro, Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, Ohio
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.

Drilling Machines, Multiple Spindle—*Continued.*
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Mach. Co., Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, Ohio.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.

Drilling Machines, Upright—*Continued.*
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Mach. Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Coates Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Dallett Co., Thos., H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Eectrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Eectric Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

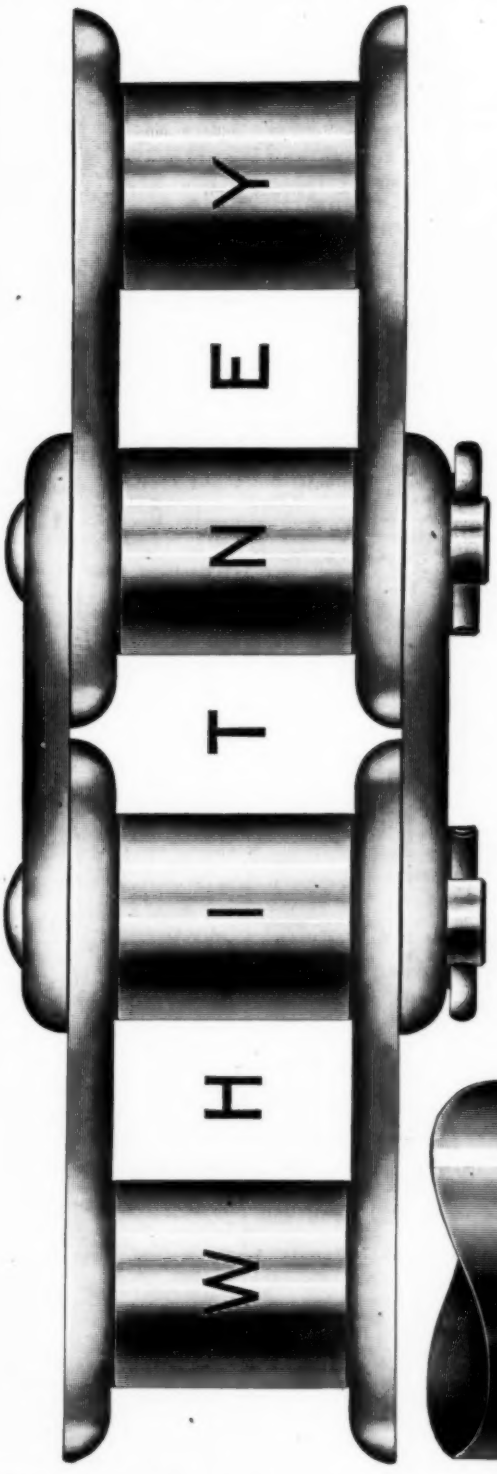
Drying Apparatus
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

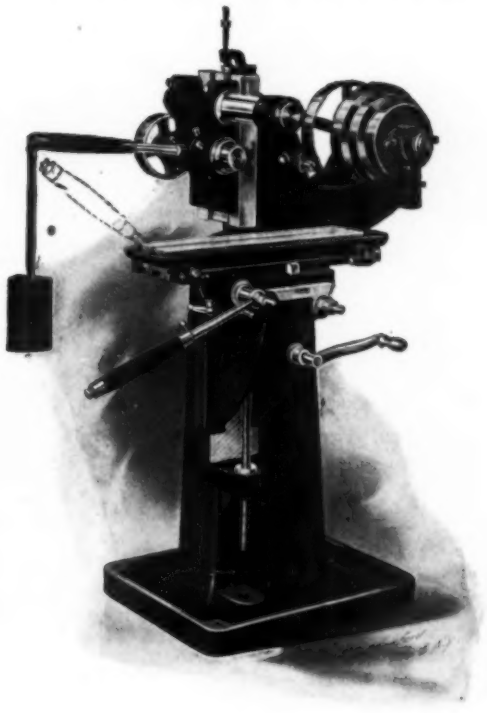
Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Clark, Jr. & Co., Jas., Louisville, Ky.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.

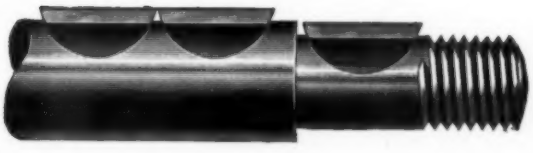
"WHITNEY" CHAINS

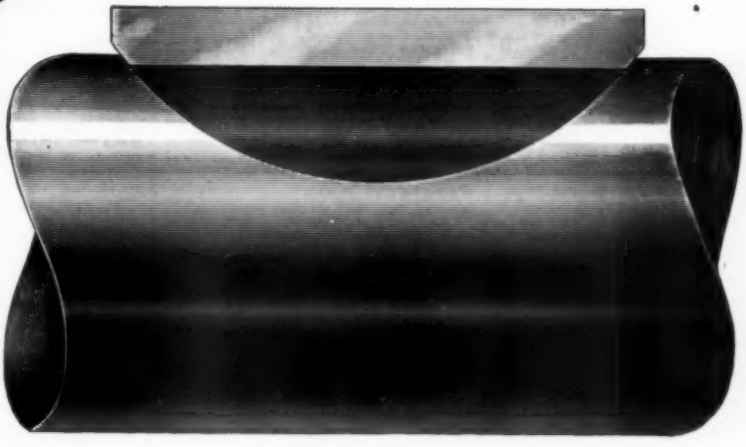
Hand (feed) Milling Machines
The Woodruff Patent System of Keying





The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Electrical Supplies—*Cont'd.*
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr. & Co., Jas., Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Mechanical and Electrical
Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Philadelphia, Pa.
Merritt, Jos., Hartford, Conn.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.

Engines, Steam
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers
Bormay Engraving Co., New York.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Philadelphia Bourse, Phila, Pa.

Expanders, Tube
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment
Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps
American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Heller Bros. Co., Newark, N. J.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York.

Filler, Iron
Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.
Simplex Mfg. Co., New York.

Fire Brick
McLeod & Henry Co., Troy, N. Y.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co, Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery
Scranton Co., The, New Haven, Conn.

Forgings, Drop
Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic
Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine
Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel
Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Crescent Forgings Co., Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
McInnes Steel Co., Corry, Pa.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gas Blowers and Exhausters
Sturtevant Co., B. F., Hyde Park, Mass.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.

Gear Cutting Machinery—*Continued.*
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide
Boston Gear Works, Norfolk, Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

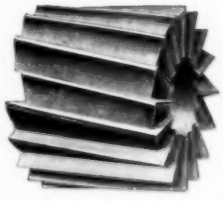
Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.

BROWN & SHARPE MFG. CO.,
PROVIDENCE, R. I., U. S. A.

Does it necessarily follow because you have a large stock of cutters to select from that you will find the cutter best adapted to your work?

A Large Variety of Styles and Sizes

may enable you to choose a Cutter of the proper style and size. But do you get the Cutter that combines correctness in design with the highest quality of material and workmanship; in other words, the Right Cutter for the job?



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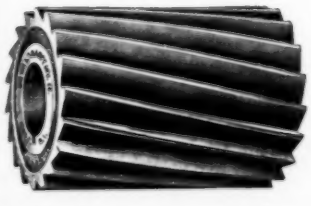
36 Styles--3700 Sizes

Each One of a Quality

that has been proven to adequately meet the requirements of the work it is to perform.



Cutter List sent to any address upon application.

Gears, Worm—*Continued.*
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets
Burke Electric Co., Erie, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas
American Gas Furnace Co., New York.

Gibs
Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Safety Emery Wheel Co., Springfield, Ohio.

Grinders, Center
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter
Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Machine Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Gardner Machine Co., Beloit, Wis.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.

Grinders, Drill
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Machine Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Independent Pneumatic Tool Co., Chicago, Ill.
U. S. Electrical Tool Co., Cin., O.

Grinders, Saw
Tindel-Morris Co., Eddystone, Pa.

Grinders, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding and Polishing Machinery
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Machry. Co., Cleveland, O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Gardner Mach. Co., Beloit, Mich.
Goodell-Pratt Co., Greenfield, Mass.
Graham Mfg. Co., Prov., R. I.

Grinding and Polishing Machinery—*Continued.*
Greenfield Mach. Co., Greenfield, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Superior Corundum Wheel Co., Waltham, Mass.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Wells Sons Co., F. E., Greenfield, Mass.

Grinding Wheels
Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames
Athol Machine Co., Athol, Mass.
Cleveland Stone Co., The, Cleveland, O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.

Gun Barrel Machinery
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Erie Foundry Co., Erie, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., The, New Haven, Conn.

Hammers, Steam
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.

Hammers, Steam—*Continued.*
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool
Cincinnati Ball Crank Co., Cincinnati, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting
Link-Belt Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hobbing Machines, Worm
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Hoisting and Conveying Machinery
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Link-Belt Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
United Engineering & Fdry. Co., Pittsburg, Pa.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker-Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hobbs, Clinton E., Boston, Mass.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Chicago Flexible Shaft Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

Hones
Chicago Pneumatic Tool Co., Chicago, Ill.
Pike Mfg. Co., Pike, N. H.

Hose
Chicago Pneumatic Tool Co., Chicago, Ill.
Rhoads & Son, J. E., Phila., Pa.
Sprague Electric Co., New York.

The Morse Chain on Cone Sprockets

A Mechanical Curio, Forming at Once a Substitute for Cone Pulleys and Belts and for Gear Boxes for Main Drives

EDITORIAL CORRESPONDENCE

It is not often that such a complete novelty as the one under illustration presents itself to the mechanical public. Should the reader doubt its working as described below, he will not be criticized. Three minutes' observation in the Ithaca factory of the Morse Chain Company would, however, dissipate his doubts, although it would require many times three minutes for him to satisfy himself of the exact manner in which it works. After seeing it in operation, his first and most natural questions would be, What made Mr. Morse imagine that the device would work before making it, and what induced him to make it? That it does work, and in a manner which leaves nothing to be desired, I can testify from repeated observation.

The device is nothing else than a cone pulley with suitable teeth in it to form a series of stepped sprocket wheels, on which a Morse chain works precisely as a belt works on cone pulleys, giving the same control of speed, and with, of course, the positive drive which accompanies the use of chains.

Fig. 1 shows a pair of boring mills standing on the main floor of the Morse chain works, both being driven by these cone sprockets from a line shaft below the floor. The general appearance of the sprockets will be apparent from this illustration, but a better idea of the manner in which the shifting of the chain is accomplished will be obtained from Fig. 2, which gives a near view of a completed sprocket, as well as a view of a sprocket blank before the teeth are cut. Two blades of steel will be seen to be inserted in the latter, placed at one-third of a circumference apart. As a matter of fact, there is a third blade on the farther side of the cone, the blades dividing the circumference into three equal parts. The sprocket steps are of such diameter that the number of teeth in each step is always a multiple of three, resulting in the teeth of all of the steps coming into line at three points of the circumference, and it is at these points that the inserted blades are placed, those portions of the blades which extend across the faces of the cones forming, in fact, the sprocket teeth at those points, while between the steps the inclined portions of the blades form teeth by which the shifting of the chain from a smaller to a larger step is accomplished. In this connection it should be remarked that the numerous teeth on the cone side are not really such, but are nothing more than gashes in the surfaces due to the over-run of the cutters when cutting the driving teeth. This will be apparent from the finished cone of Fig. 2 in which the inserted blade will be seen to form a continuous tooth up the cone sides and across the driving faces while the other gashes in the cone sides are continuous with the spaces of the steps below them, but out of step with those above.

The act of shipping the chain from step to step is precisely the same as that when shipping a belt from step to step of a cone pulley. By a slight side pressure on the advancing side of the chain it is run down hill on one cone, and by corresponding pressure on the advancing side near the other cone, it is thrown slightly sidewise into engagement with the inclined tooth, when, quick as a wink, it mounts

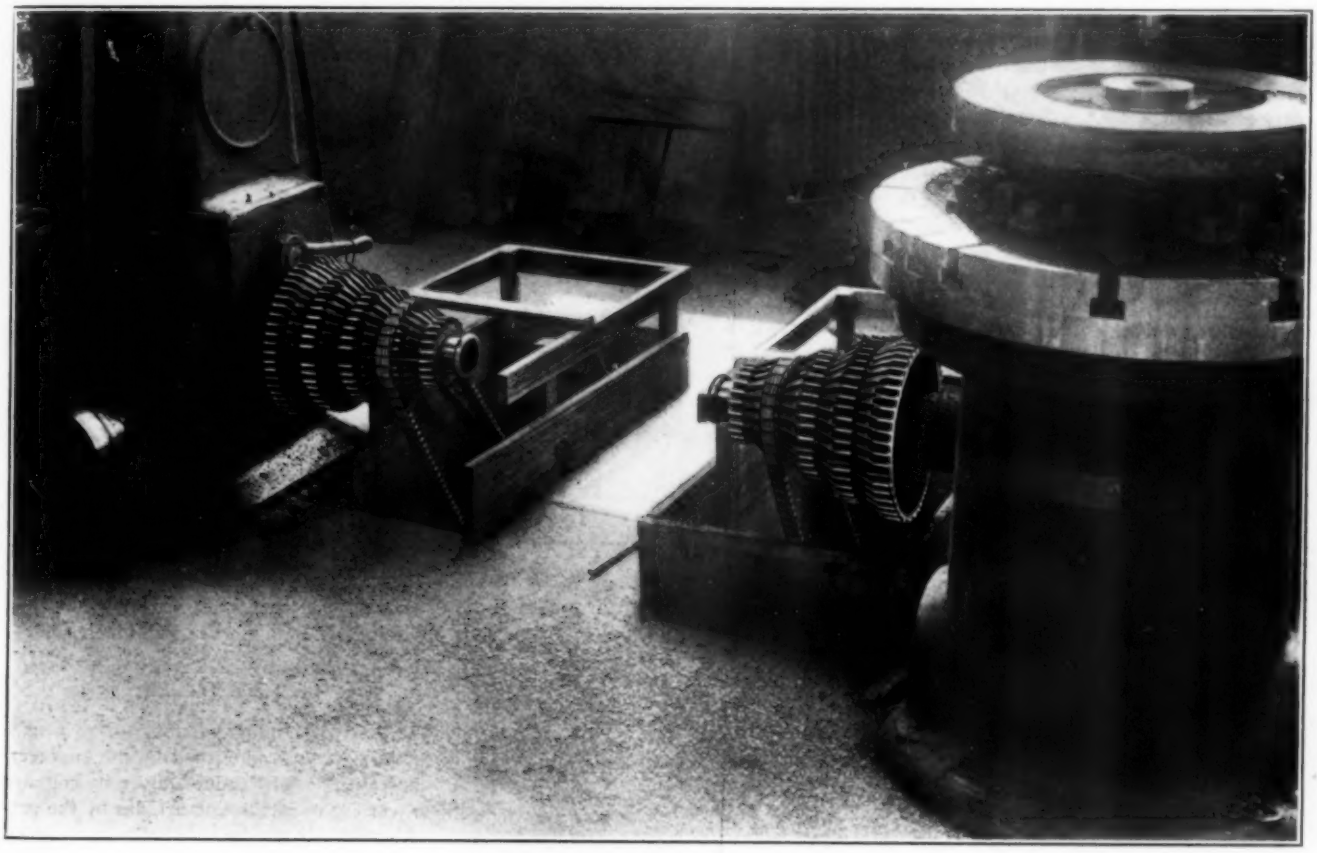


FIG. 1. TWO APPLICATIONS OF THE MORSE CONE SPROCKETS

the intervening incline and finds its seat on the larger step.

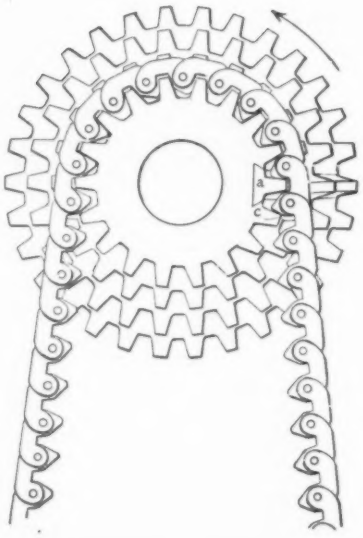
On first seeing the operation the observer will ask how it is possible for the chain to slide up the cone side teeth with their constantly increasing distance apart without something breaking. The action may be understood by referring to Fig. 3 in which a continuous tooth is shown at *a*. Remembering that the chain is first run down hill on the opposite cone, it follows that during the second shifting it is quite slack, and when side pressure is applied at *b* the chain at once rides over the continuous tooth *a*, gap *c* of the next chain link engaging with *a*, under which condition the chain is free to mount the sprocket step.

The shifting is done with remarkable ease—quite as readily, in fact, as with a belt, the bare hand being used, and while a mechanical shifter has been schemed it had not been applied as no need for it has been found. With larger machines and wider chains such need will no doubt develop, and in such cases the shifter will be applied.

The chain is in all respects precisely the same as the regular Morse chain, except that it has no guide link at the center of its width—the sprocket being without the usual groove for this guide link. Regarding the absence of this provision for keeping the chain in place, Mr. Morse says that as regularly used, there would be no need of this guide link were it possible to assure correct alinement of the shafts in all cases. The whole tendency of a chain is to stay in place and not to leave its place, provided the shafts are properly alined. Of course, in work of the character to which it is contemplated that this device shall be applied, such alinement may be depended upon, and it is hence entirely safe to omit the guide link.

There are now upon the shop floor of the Morse Chain Company six boring mills, driven in the manner shown. These installations have been made since the recent removal of the works to Ithaca, N. Y., but Fig. 4 shows an installation which was originally placed in the Trumansburg shops four years ago, and which has been running during this entire time. The machine shown is a No. 1 milling machine without back gear, the piece of work in progress being a sprocket of 35-point carbon steel, with teeth of nine-tenths inch pitch. The feed maintained is one-quarter of an inch per minute, which, of course, is not fast, except when the machine on which the work is done is considered, as, when fitted with a belt drive, the machine was entirely incapable of such work as that here shown. To show better the nature of the job, Fig. 5 is added which gives full size the profile of the cut taken—the metal being removed at a single cut.

The chain-driven boring mills stand in a row and are driven from a line shaft below the floor on which the reverse cone sprockets are mounted, the stopping and starting being accomplished by a multiple-washer friction clutch within the lower cone. F. A. H.



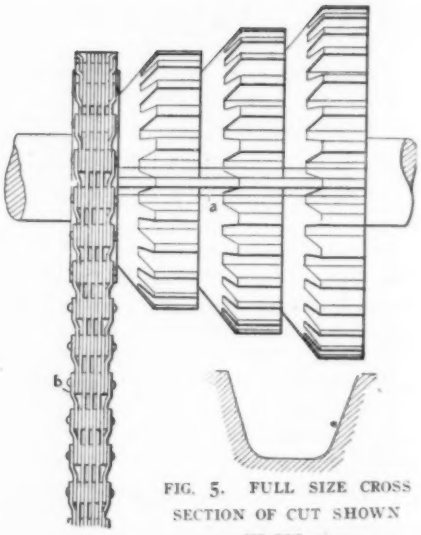


FIG. 5. FULL SIZE CROSS SECTION OF CUT SHOWN IN FIG. 4

FIG. 3. THE ACTION OF THE CHAIN IN SHIFTING

FIG. 2. ONE SPROCKET COMPLETE AND ANOTHER READY FOR CUTTING

The 1907 number of the *Purdue Engineering Review*, published by the engineering societies of Purdue University contains a variety of interesting articles by the professors and students of the university, covering civil, mechanical and electrical engineering. Among these we may mention an article on "Works Management," by R. A. Smart, an account of some locomotive road tests by several 1907 men, a short description of the hydro-electric power development at McCall's Ferry on the Susquehanna; an article on producer gas, prompted by the installation of a producer plant at Purdue; an article on the values of various fuels, by Professor Evans; a quite complete description of the General Electric Company's test department and student engineers' course at Schenectady, by E. L. Simpson; the empirical design of reinforced concrete arches, by D. B. Luten; tests of pipe coverings, a review of engineering conditions in the Northwest, by H. A. Cook, etc.

An Inexpensive Indexing System

By Wm. E. Reed

I am sure that there must be many readers of the American Machinist who would at once begin a clipping file for their own personal and private use, if they only knew how easily it could be started and how satisfactorily it could be maintained.

I speak for the thoughtful man who reads, and who, though he may not fully realize it, would be greatly benefited by some simple, practical system by which he could preserve, and so preserve that he could easily find, the many valuable articles that come to his attention.

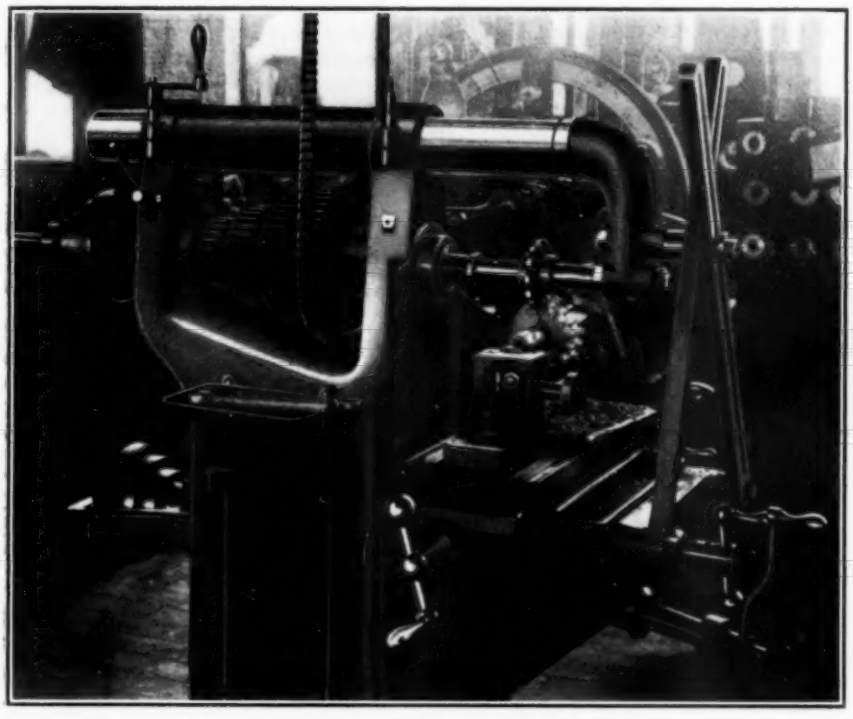


FIG. 4. A CHAIN-DRIVEN MILLING MACHINE

Let me tell you something about the system I use. First, I got some open-at-the-side manila envelops, a thousand, I think, for seventy-five cents. They were 5x7½ inches, and although the size was an experiment, it has proved very convenient. I made a drawer to hold the envelops; though the pasteboard box they came in would have answered every purpose, at least for a while. The drawer is high enough and wide enough so that the envelops can be filed vertically, that is with the flaps uppermost.

I bought an inexpensive card-indexing outfit consisting of a neat buckram-covered pasteboard box, provided with alphabetical guide cards, and with two hundred 3x3 white record cards. This cost sixty-five cents. Were I to begin again, however, I would start with the next larger size, which costs but a trifle more. Lastly I made, because I could not buy in small quantities, two dozen "box envelops," such as books are often mailed in. These box envelops are made of a medium weight manila board, are one inch thick by 7¼x9½ inches. They open at the end, which in my case is used as the top, and are provided with flaps to make the boxes as dust proof as possible. Then I arrange them on shelves just as one does books.

Using the Outfit

This is my outfit. Now a word about how I use it. I am fond of keeping clippings, not only of mechanical and engineering achievements, tools, machinery, etc.; but personal sketches of men I admire, booklets of places I have visited or expect to visit, samples of various fabrics and metals, factories of improved design, and public buildings of note. For each one of these subjects I have an envelop. One for each man, town or place, factory, etc. In fact, whenever I read anything on a subject that interests me especially, I cut the article out, if it is practicable, write on the back indicating when it was found, put it in one of the 5x7½-inch envelops, number the envelop and file it away in the drawer.

The filing of these envelops is very simple. It is done entirely according to the number which each envelop bears. The numbers are written in the upper right-hand corner, and are given to each new envelop consecutively, beginning with any number that one may choose—1 or 100, or any other. Each envelop has the subject of its contents written in the left-hand corner, but this is purely for convenience and not for filing.

Having made out the envelops, as described above, the next thing is to write out a corresponding card for the card index, which is done by writing the envelop subject at the top of the card, and in the upper right-hand corner the filing number of envelop in question. These cards are arranged in the card index alphabetically, according to their subject headings. So that whenever one wishes to consult the data on file, if the number isn't remembered, it is only necessary to turn to the card index, when the alphabetical arrangement enables one to find, in a moment, the card bearing the desired subject. This card gives the number of the envelop where the data is filed.

An Example of Its Use

The last envelop I have added to my collection may serve as an example. It bears the name of dear old "Uncle" John Fritz. A few days ago I received from a friend of mine a periodical, in which was a delightful sketch of Mr. Fritz' life, with some interesting illustrations of the man and his home. I did not care to preserve the periodical itself—it was too bulky—but I wanted very much to keep the article, and to have it where I could turn to it at any time. It was the work of but a moment to cut out the two pages on which it was printed, place them in an envelop marked "Mr. John Fritz" in one corner, and my next number, 300, in the other corner, write out an index card, as described above, file it under Fr in the card index, and file the envelop with the others in the drawer, placing it between numbers 299 and 301. This represents the maximum work for any case. Next time it would only be necessary to cut out the clipping and put it in the envelop, for the "making out" of the envelop and the card, having been once done, it is done for all time.

The index card is a good place to note other references to the subject, such as certain pages in books from which, for obvious reasons, the matter could not be cut. Besides this, it is very desirable to place on the index cards, references to other kindred subjects, for which there may be envelops already on file. But always be sure to give the reference number, so that the envelop can be turned to directly. For instance on the index card in the case cited above is this notation: "See John Fritz Medal—Envelop 390."

Use of the Box Envelops

The box envelops, already referred to, are used for filing catalogs and booklets. Anything in the pamphlet line not larger than 7x9 inches will easily go inside, and the size covers the great majority of such publications. I place the catalogs in these box envelops according to subjects, indicating the subject on a label on the outside of the box, and filing the

boxes according to the letters of the alphabet, each box having its letter. On the index card, the reference letter of the box envelop appears close beside the reference number of the 5x7½-inch envelop, but there is no confusion, for the number always refers to the envelop with the clippings, and the letter, to the box envelop with the catalogs or pamphlets, and one turns accordingly to the kind of matter desired.

Always be sure to mark on the back of the clippings from what paper or magazine they were taken. Give the data in full, and the page. For this purpose I find the black "checking crayons," as they are called, best adapted. They make a wide mark that at once catches the eye and they are much better than pen or pencil.

I have said that the envelops in my file were arranged according to number and without reference to subject. There is one case, however, in which this should be qualified. When an envelop has received all the matter it can conveniently hold, I make out a second, giving it the same number as the first, but I add a letter of the alphabet, and then file this second envelop next to the first in the drawer.

Filing the envelops according to number has decided advantages. It saves much time at the outset, for by this method it is not necessary to think what department or subject the new envelop must be filed under. Merely give it its title and its number. The card index does the rest.

Do not be afraid to make out new envelops. The more subjects, and consequently envelops, you have, the easier it will be to find just the data you are looking for. Make specific headings and not general ones. For example, do not have such a subject as "recipe," but make out separate envelops for each kind of recipe, glues, cements, solders, lacquers, stains, enamels, belt dressings, etc., etc., if these are the ones that you use most.

By some such system as this one quickly acquires envelops covering the subjects that are of the greatest interest. Begin with a system like this, and let your own needs point you to improvements that will make it peculiarly adapted to your particular requirements. Such a system demands very little work, it is always ready when you want to consult it, and it grows in value with its use.

A Slide Rule for the Strength of Gear Teeth

By Harry Tilsley

The readiest means yet devised for applying the Wilfrid Lewis formula in determining the strength of gear teeth is due to Mr. Barth. Users of the ordinary slide rule would, I think, prefer a straight slide rule to his circular one.

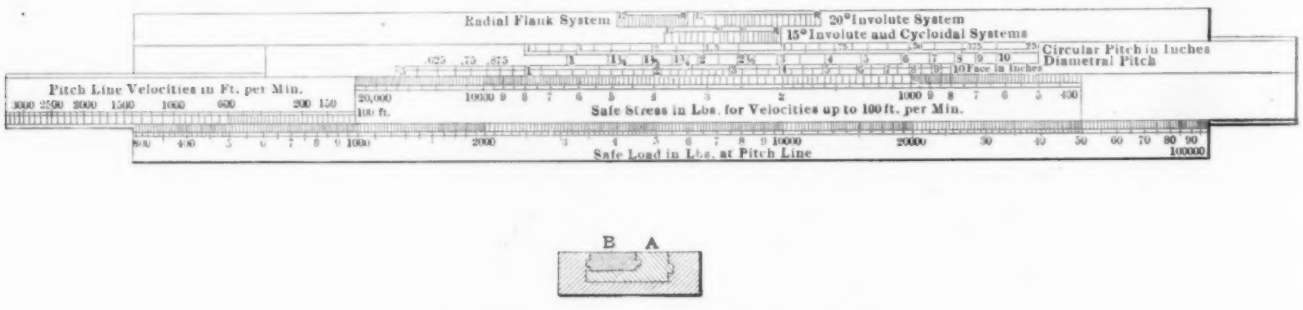
Such a rule is shown in the illustration. It consists of a stock and two slides *A* and *B* as shown in the section.

At the top of the stock the three sets of the factors "y" are shown, corresponding to the three systems of tooth form. Those for the 15-degree involute system are at the edge. Each division cannot be marked with its tooth number, but this difficulty can be overcome by making on the plain part of the stock those tooth numbers that have a different factor, as 12, 13, 14 — — — — — —100, 150, 300, rack.

The slide *A* carries three scales. The upper shows the circular pitch in inches, the middle the corresponding diametral pitches and the bottom scale shows the face of the wheel in inches. The slide *B* has two scales. The upper one is for the safe stresses in the material for velocities up to 100 feet per minute and the lower scale shows at a glance the safe load for velocities from 100 feet to 3000 feet. The bottom scale on the stock shows the safe loads carried at the pitch line in pounds. The only use for a runner is to bring the tooth factors for the radial flanks and 20 degree involute systems to the edge of scale *A*, and to bring the diametral pitches to this same edge. The pitch scales could easily be reversed so that system is brought to the edge which is the more used. For the tooth factors the eye often can serve.

To use the rule the pitch on scale *A* is brought opposite to the tooth factor in the stock. With the slide *A* in this position, the safe stress on slide *B* is brought opposite to the face of the wheel. With the slide *B* in this position the safe load at the pitch line is read opposite to the velocity. In the figure we have a 1-inch pitch rack 1 inch width of face at 100 feet per minute carrying 990 pounds per tooth, the real value being 962 pounds.

M——, England.


Radial Flank System
20° Involute System
15° Involute and Cycloidal Systems
Circular Pitch in Inches
Diametral Pitch
Face in Inches
Pitch Line Velocities in Ft. per Min.
Safe Stress in Lbs. for Velocities up to 100 ft. per Min.
Safe Load in Lbs. at Pitch Line
B
A

A SLIDE RULE FOR THE STRENGTH OF GEAR TEETH

Expansion of Germany

The London *Financial Times* publishes the following summary of the annual report on the foreign trade of the German empire by the British consul-general at Berlin:

Much has been written of late about the prosperity of the United States, but it may be doubted whether even in that marvelous country the conditions of economic life have shown a more exuberant vitality than has prevailed of late in Germany. We have before us the annual report of Consul-General Schwabach on the trade of the fatherland for 1906, which was published on May 28. It is a picture of intense activity. The year, in fact, has proved the high-water mark so far of the country's economic development. The quantities of goods placed on the home and the foreign market by German factories reached record figures. Enlargements of factories, which drained the resources of the money market, were still barely sufficient to cope with the demand. Work people, both native and foreign, were fully employed, and in some industries there was even a shortage. As in America, railway rolling stock proved insufficient to cope with the growing needs of trade. Even agriculture shared in the general prosperity, and one of the best features of last year's business was the continued expansion of the home market.

A few figures will serve to emphasize the striking nature of last year's progress. The new joint stock companies floated in 1906 totaled 212, with a capital of over $117,000,000, comparing with 198, with a capital of under $100,000,000, in 1905, and with 104 companies having a capital of only $36,000,000 in 1904. The Prussian savings banks showed the great increase of $131,000,000 in deposits in 1905 to a

total of $2,020,000,000, and no doubt the returns for last year, which are not yet available, will exhibit a further expansion. But, perhaps, the growth of Germany's wealth is best demonstrated by the income-tax returns. These show that in 1900 the number of persons liable to income tax was 3,380,000, and the total income assessable was $2,007,134,000. Last year the number was 4,675,000 and the assessable total $2,609,889,000. The increase last year was about 7 per cent. as against 1905 on the amount of income taxable, but since 1892 the advance has been no less than 80 per cent.

Concerning the commercial treaties the British consul-general's report says:

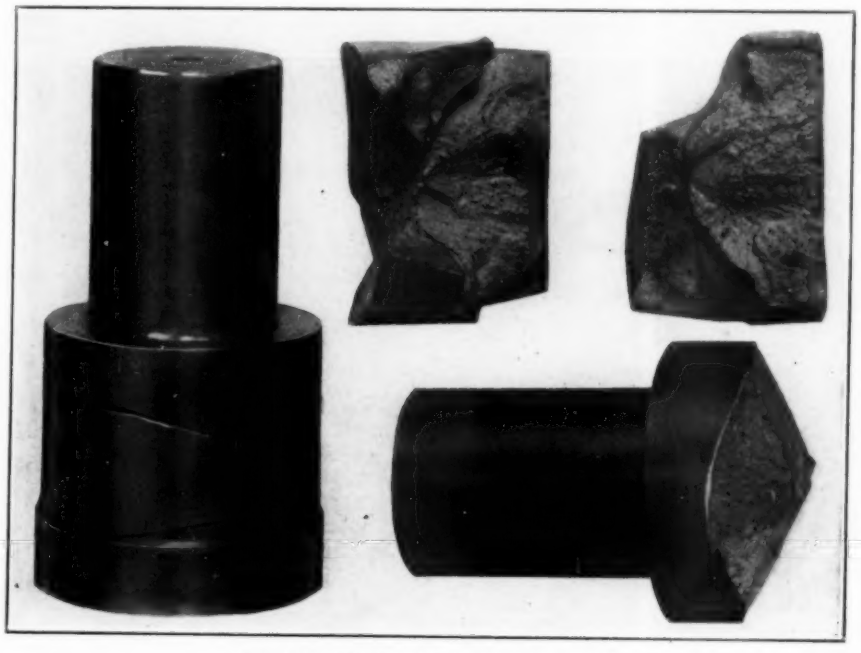
"The new commercial treaties have given rise to many anxious fears among those interested, and these forebodings have been echoed in the German press. If these pessimistic prognostications have not as yet been verified, they have by no means been proved to be unwarranted. The period during which these treaties have been in force is still far too short to judge of their effect; moreover, the unusually favorable condition of international commerce secured markets to German trade of which it would, without doubt, have been deprived in times of less industrial prosperity. In spite of all the impetus given to trade by the prevalent international activity, complaints have been made in various industrial branches to the effect that under the régime of the new commercial policy the profits on their exports are diminishing."

A rise in the cost of the necessaries of life is another untoward effect of the new tariff. Nevertheless, in spite of all hindrances, the fact remains that 1906 was a record year for German trade and industry, and the empire was never more palpitating with energy and vitality than it is today.

Internal Strains in Steel

By Chas. A. Trask

The accompanying cut shows what was a piece of steel 4½ inches long and 2½ inches diameter at the large end, which had been upset from 2¼-inch stock, and turned to the shape shown, to be used as a punch. It had been hardened, and the surface shows that it had been overheated. It had been polished in the lathe and returned to the blacksmith to be tempered. Having a good-sized clean fire, our friend of the hammer and tongs laid the piece in the fire, and turned on the blast. An explosion followed, and though no one was hurt they had to search the shop for the steel. The pieces were finally gathered together, and the cut shows the condition they were in. I have seen many pieces of steel that cracked in the bath while being hardened, and before being tempered. These were usually comparatively frail pieces, but this, I think, is the first time I have seen a solid mass fly in pieces in this manner. The reason is obvious—the steel was overheated, and then plunged into the bath; the outside surface cooled quickly while the center was still hot; as the center cooled, intense internal strains were set up due to contraction. The tensile strength of the steel was impaired by the high heat. The sudden application of heat to the surface served to increase the stress on the already over-strained structure beyond its ability to hold together, and under the circumstances it would not have been surprising if the heat generated by the friction of the emery cloth in the speed lathe had caused the "explosion" while in the grasp of the man who was doing the polishing, in which event it is highly probable that some injury would have been inflicted.



EFFECT OF INTERNAL STRAINS ON STEEL

A New Style of Rails and Their Price

An important meeting was held in New York lately, attended by representatives of the manufacturers of steel rails and high officials of different railroad corporations. It was called by the United States Steel Corporation for the purpose of discussing a method of arriving at satisfactory arrangements between rail makers and railways regarding new and proper specifications necessary to insure perfect rails and to decide upon the question of the cost thereof. It would seem that certain of the manufacturers have insisted upon a higher price for rails made under the new specifications which have been formulated by the Pennsylvania, that company having taken the lead in adopting changes in the shape and method of manufacture. It is stated, in fact, that these changes are very radical. The Cassatt section, as the Pennsylvania's new type of rail is denominated, from the fact that it was devised by the late president of the company, A. J. Cassatt, calls for a heavier flange, so that the flange and the crown, that is to say, the bottom and top of the rail, will be of nearly the same width and dimensions. In the present form of rail, the flange being lighter than the crown, the rail cools imperfectly, and is more likely to fracture than would be the case should this improvement be adopted. The new Pennsylvania specifications also call for the cutting off of at least 25 per cent. from the top of the steel ingots used in making the rails, instead of 15 per cent., as at present. The claim of the steel manufacturers that the cost would be seriously enhanced seems, therefore, to have some foundations, but that it would be unprofitable to make rails under the new specifications at the present price of $28 per ton is regarded as somewhat open to question. It can, however, be readily understood that a higher price will be asked for rails of the new type.—*Bradstreet's.*

A new process for smelting wrought iron and steel directly from the ore is attracting considerable attention in Australia. The chief claim made for the process seems to be that the heat required for re-melting, as steel is commonly made, is saved, the metal in the new process, once brought to the necessary temperature, being not cooled until it reaches the final stage of the finished product. An experimental plant of considerable capacity has been erected and favorable reports have been made on its performance.

General Concrete Machine-shop Equipment

Equipment of Buildings Other Than Those Devoted to Manufacturing Purposes, in Plant of United Shoe Machinery Co., Beverly, Mass.

BY L. P. ALFORD

While the articles beginning on pages 829, Vol. 30, Part 1; 3, Vol. 30, Part 2, of the AMERICAN MACHINIST deal with the general equipment and arrangement of the manufacturing departments, this article will deal with the outlying buildings and associated departments in the plant of the United Shoe Machinery Company, at Beverly, Mass. These associated departments are the power station, foundry, hardening room and drop-forging room.

THE POWER STATION

In Fig. 1 is shown an interior view of the generator room of the power station. The prime movers are Curtis steam turbines in the units of two 500-kilowatt and one 1000-kilowatt capacity. The generated voltage is 600 volts and the current is alternating, three-phase, 60 cycles. The marble switchboard, which is seen at the left of the cut, furnishes control for all of the power and lighting circuits for the entire plant; but several circuits are grouped behind each main feeder switch. In the basement directly beneath the switchboard is the point of distribution. At this point are barrier blocks with fuses, and all of the circuits leave this point and pass through the tunnel system to the various buildings.

In this basement is the condensing machinery for the two 500-kilowatt turbines. These are surface condensers. The 1000-kilowatt machine which was installed during last year is provided with a barometric condenser of the Bulkley type. At about the center of the illustration will be noticed a marble panel carrying a number of pressure gages for all the various services of the plant, in addition to a clock controlled from the master in the main office and a boiler steam-pressure recorder.

The switchboard has recording instruments for lighting- and power-current consumption. There is a special panel connecting the main board with the service of the city of Beverly for overtime work.

Fig. 2 is another view of the generator room and shows the condenser basement and, at the far end, the pumping machinery. Here are located the pumps for all the various services of the entire plant. There are two pumps for boiler-feed purposes, one pump which furnishes the domestic water supply for the plant, an underwriters' fire pump so piped that it can be operated in conjunction with the domestic water pump as an auxiliary, and a pump for the plunger elevator water supply. The underwriters' fire pump is so arranged that it can furnish water at a pressure of about 80 pounds to the general water service throughout the plant, and it also can be used for furnishing water at a pressure of 170 pounds to the hydrant mains which surround the building. A duplex steam-driven air compressor furnishes air at 80 pounds pressure for the foundry and general use.

The hight of this room, together with the ventilating windows at the top, insures a cool, pleasant generator room under all conditions of service. This hight is well shown in the two half-tones which have been referred to. The provisions for natural light are of the best. At the rear of the room is shown, Fig. 2, the hand traveling crane which serves the generator-room area, and is capable of handling the largest individual piece entering into any of the generators or pumps.

The fire room, which is separated from the generator room by a solid concrete wall, is provided with 2200 rated horsepower of water-tube boilers. This room has the same hight as the generator room, and thus has the same advantages in connection with ventilation and light. The boilers are equipped with an economizer system.

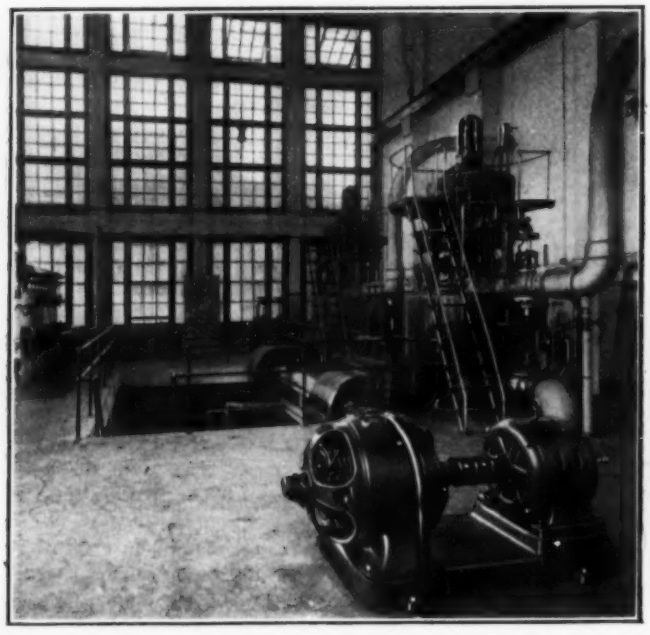


FIG. 1 THE GENERATOR ROOM

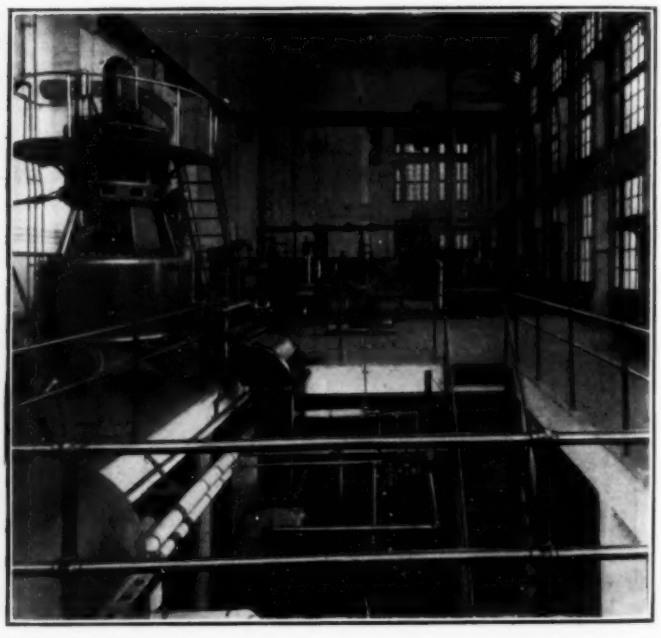


FIG. 2

THE FOUNDRY

The foundry is somewhat out of the ordinary in that the molding floor is on the second-floor level. It is covered with a high-posted pitched roof, the center span of which has a large monitor.

The floor itself is of reinforced concrete and proves eminently satisfactory for molding work. Around the cupolas sand beds 7 inches deep are provided to catch the contents of the cupolas when the bottoms are dropped. The aisles used for transporting metal and castings are paved with brick to facilitate repairs.

FIG. 3. THE MOLDING FLOOR

FIG. 4. A HEAVY MOLDING SECTION

The noticeable feature of the molding floor is the excellent light. The ceiling is very high, and the large center monitor adds greatly to the light in the interior of the room. This feature is also of service in carrying off the gases and smoke at the time of pouring. In fact, although the foundry pours about 35 tons of metal per day, there is no trouble from the congestion of gases and smoke.

It will be noticed that the roof is steel framed, covered with planking. It was deemed inadvisable to construct this roof of concrete because of its great hight and the long spans.

Fig. 3 shows the molding floor. It is 108 feet wide and 380 feet long. The width is sufficient to give three molders' floors with two aisles, one on either side of the center floor, equipped with an overhead suspended I-beam track for the transporting of molten metal and castings. The left-hand side of the room is used almost entirely for molding machines. The center is used for light floor work and some bench work, while the right-hand side is used for the heavier floor work, requiring the use of cranes and hoists. Fig. 4 shows one of the side bays with the cranes and hoists in place. Electric hoists are used entirely for this work. The work, however, is comparatively light, the heaviest hoist used having a capacity of only four tons.

The coremaking is done on the molding floor itself, near the cupolas. Fig. 5 shows a part of this section, looking toward one of the concrete core ovens. The ovens are fired with coke. A crane serves the area in front of the ovens and is used for loading large cores on the cars.

Turning now to Fig. 6, we see the cupolas and charging floor. These are located roughly at the center of the building. There are three cupolas, as shown, served by an I-beam trolley track. This track branches to all parts of the molding floor. It is provided with cross-overs and switches at frequent intervals to facilitate the moving of ladles for metal from and to the cupolas at the time of pouring. A switch is plainly shown in the foreground of Fig. 4.

The charging floor is of concrete, as are the side walls which separate the melting area from the rest of the molding floor. An elevator serves this level from the

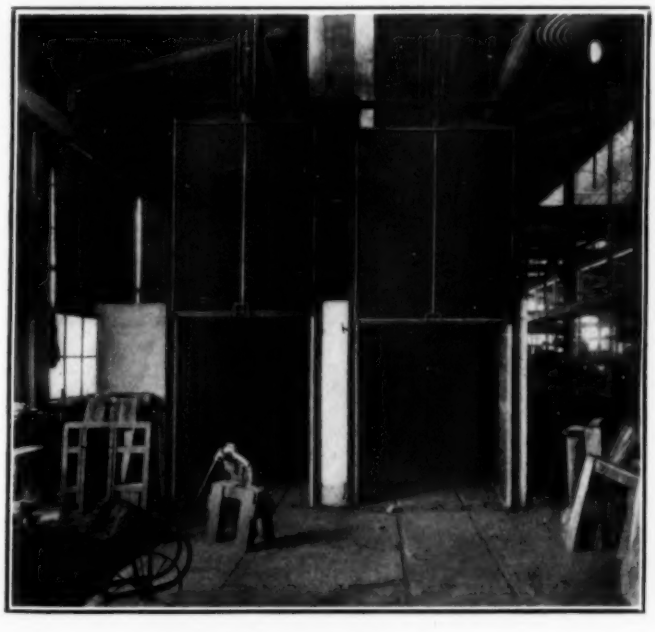


FIG. 5. CORE OVENS

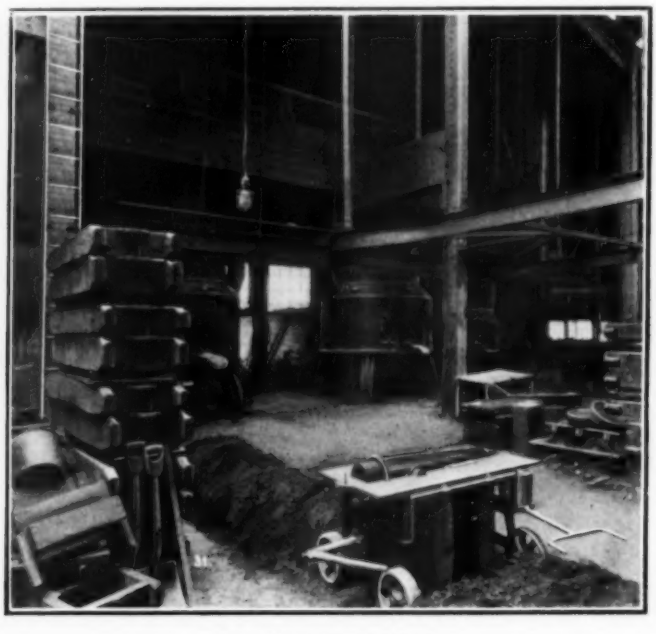


FIG. 6. THE CUPOLAS

ground floor, and thus the pig-iron storage yard, and also from the basement in which is stored the coke.

On the first or ground floor are the blowers which furnish air to the cupolas. These are shown by Fig. 7. The blowers are all motor driven, the connection being a rawhide pinion and cast-iron gear. In the room with them is a direct-current generator belted from a motor which furnishes current at 110 volts for use in the electric hoists.

The ground floor level also has the general cleaning room, pattern-storage room, flaskmaking room, metal-pattern room and the washing and toilet facilities for the entire building. In these various departments there is nothing especially interesting outside of the wash rooms. These rooms are provided with metal clothes lockers for the general foundry help, and with special shower baths for the molders. These shower-bath compartments were made from designs of the United Shoe Machinery Company, and are well worthy of description. Fig. 8 shows a plan of one of these shower-bath rooms, and Fig. 9 is a photograph of some of these compartments.

The compartments are made entirely of galvanized iron supported on a framework of galvanized angles. Each compartment can be divided into two rooms by means of a rubber curtain. In the inner room is a shower-bath head, shelf for a bucket and a bucket cock. A mixing valve supplies water at any temperature which the molder wishes, either to the shower-bath head or to the bucket. Thus the molder has his choice of whichever method of washing he prefers. The outer room of the compartment is provided with a seat to be used in dressing, and the door of the compartment is arranged to swing back against the side partition and lock, so as to form behind it a locker space, in which the molder's day clothes can be kept. From the large number of baths which are taken daily by the molders, one can judge to the extent of their appreciation of these utilities.

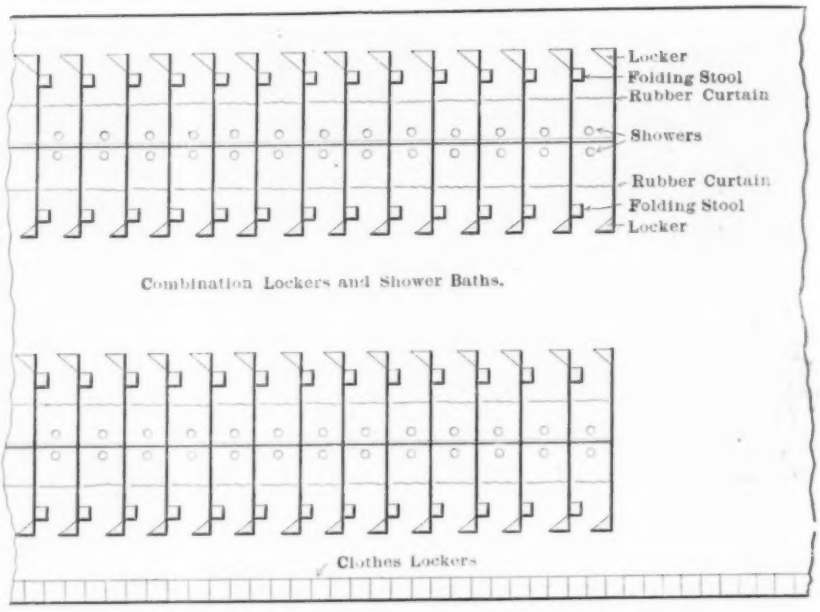


FIG. 8. PARTIAL PLAN OF FOUNDRY WASH ROOM

Individual washing sinks are also provided in connection with the metal lockers for the use of employees other than the molders. Hot water is supplied to the wash bowls and shower-bath compartments from a tank controlled with thermostatic valves. In passing, it might be mentioned that this hot-water supply is also piped to the pickle bed, so that hot water is always at hand for use in washing castings after pickling.

The basement of the foundry is used for the storage of sand, coke, clay, and other foundry supplies. Chutes lead from the ground level into bins located in this basement, so that material is unloaded from the cars by gravity. In this basement is a series of sand mills having independent motor drives, so that the sand is screened, riddled and mixed before being taken up to the molding floor. Two elevators serve this building, running between the molding floor and the general floor, one at either end. They are used mainly for bringing down finished castings to the ground floor level for the cleaning operations.

The Hardening Department

Fig. 10 shows a lay-out of the hardening department. This is in a one-story building, having concrete walls and a steel-trussed wood-covered roof. It has no interior columns, the trusses being carried the full width of the building, or 60 feet. This room is provided with louver shutters for all of the windows, so that the light is kept subdued. By reference to the illustration, it will be seen that it contains case-hardening furnaces, lead-top, tempering and drawing furnaces, and the necessary brine, oil and water tanks for plunging.

Two kinds of fuel are used: fuel oil and

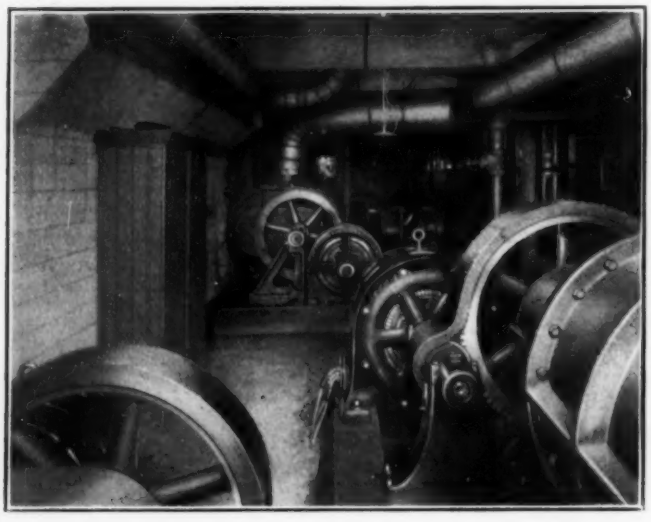


FIG. 7. THE BLOWER ROOM

FIG. 9. THE FOUNDRY WASH ROOM

gas. All of the larger furnaces burn fuel oil, but some of the smaller ones are fired by gas. The fuel oil is burned in what is known as a low-pressure system, the air for atomizing and combustion being furnished at a pressure of about 2¼ pounds. An auxiliary air supply, however, is provided at a pressure of 80 pounds. This is for use during night work, or at times when it is impractical to run the large blower for the low-pressure air supply.

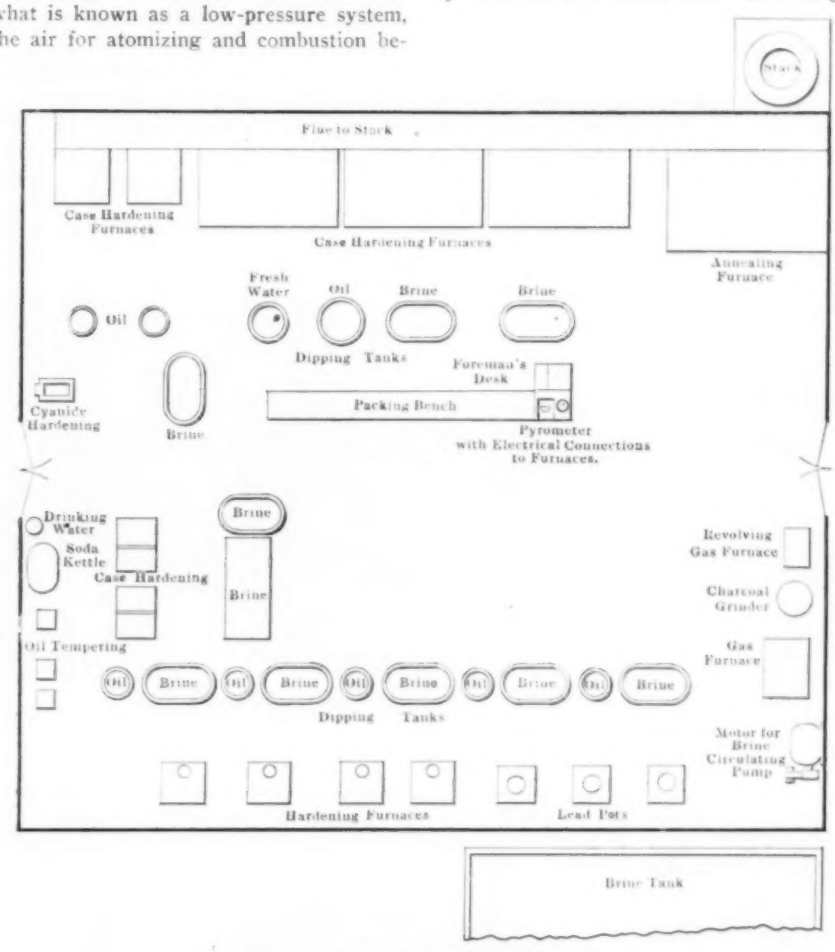


FIG. 10. PLAN OF HARDENING ROOM

Situated in the ground outside of the building is a concrete tank, holding about 20,000 gallons of saturated brine. Connected with this tank is a centrifugal circulating pump so that a circulation of brine is constantly passing through the brine hardening tanks to maintain a uniform temperature. The oil-dipping tanks are kept cool by a circulation of cold water through a coil contained in them. This method is considered a better practice than the circulation of the oil itself. The case-hardening furnaces are all connected with a Le Chatelier pyrometer and the lead pots are provided with the Bristol pyrometer.

This department is arranged for hardening all grades of steel, in addition to annealing and carbonizing work. The large case-hardening furnaces are provided with pneumatic hoists for use in handling the large pipes and pots of work. Only a very limited amount of natural light is allowed in this room, in order that the heat may be properly seen by the various hardeners. The large furnaces are provided with natural draft. This, however, is not found necessary in connection with the smaller furnaces, and the heat from them is discharged directly into the air, and finds its escape through the monitor in the roof.

The Drop-forging Department

The drop-forging department is located in the building containing the hardening room, a concrete fire wall separating them. A view taken in this drop-forging room is shown in Fig. 11. Here all the drop forgings and hand forgings for the entire plant are made. The hammer equipment consists of board drops from 250 pounds up to 1500 pounds, and steam drops from 800 pounds up to 3000 pounds. The department has a capacity of about 300,000 forgings per month, varying in size from some which weigh only a few ounces to forgings which weigh 150 pounds. All grades of bessemer, open-hearth, tool steel and some special steels are forged. The furnaces are heated by fuel oil, a continuation of the same system which is used in the hardening room.

This room also contains presses for sprue cutting, and hot trimming, presses for cold trimming and snagging wheels. By making use of the annealing furnaces in the hardening room this building can produce drop forgings complete, with the single exception of the pickling operation. This pickling is done in one of the rooms on the lower floor of the foundry building.

The type of building is excellently designed for the purpose intended. The high roof—the lower chords of the trusses are 23 feet from the floor—gives ample ventilation and opportunity for the removal of gases and heat.

In this building, as in all others of this large plant, the comfort of the employees is cared for by providing rooms containing individual lockers, individual washing bowls, and a large supply of shower baths.

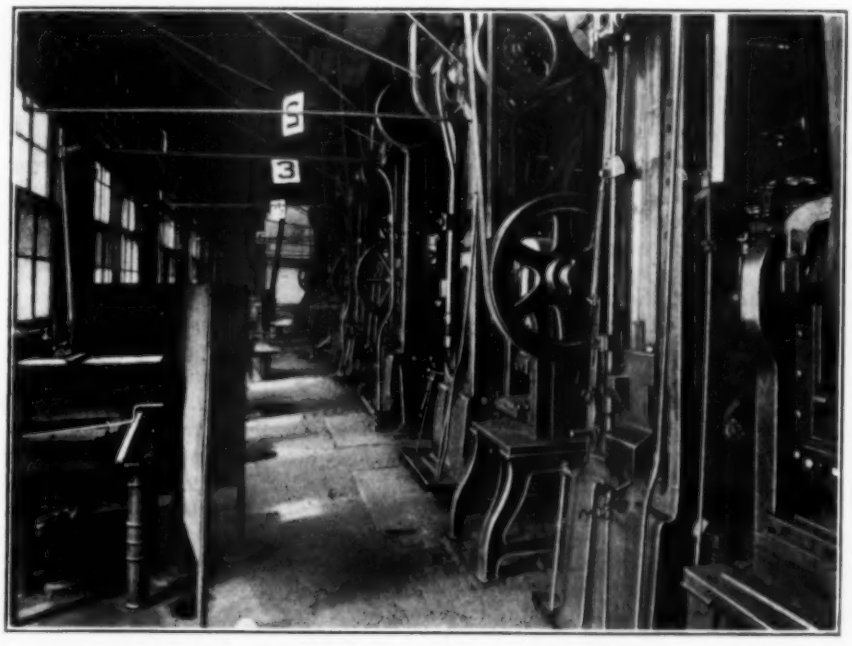


FIG. 11. THE FORGING SHOP

Plate Molding — A Three-part Piece Made in a Two-part Flask

By G. Buchanan

The molding of three-part work in two-part flasks is now becoming well known in many foundries. The plate molding of pieces such as are shown in Fig. 1, is, however, not so well known and fills up a gap which comes between loose patterns and machine molding of this class of small wheel work, the gap referring to production. This small work is very costly to make from loose patterns, only a very small output being obtained for the day's work from a bench molder; while on the other hand, the production of such pieces mounted on three molding machines is enormous, and the cost of molding was reduced in several known cases to about one-tenth of the cost of hand molding.

The Outfit for a Moderate Output

The production of these small wheels, which form parts of machines, does not generally call for the quantities obtainable from the molding machine; in the present instance a medium quantity is desired—say a few thousand castings every three months. A week's work from the plate pattern supplies this want, and the remainder of the time the patterns are lying idle. It is therefore important that the cost of the plant required is not out of all proportion to the profit reaped.

The special plant charged to this particular job comprises the plate patterns and two iron frames, the molding flasks being in everyday use in the foundry. Fig. 2 is the plate pattern; Fig. 3, plate with joint-forming frame *A;* Fig. 4, drag part of mold and flask; Fig. 5, plate with frame *B*, prepared for molding middle part; Fig. 6, plate with middle part rammed and frame *B* removed; Fig. 7, mold with cores set; Fig. 8, mold closed.

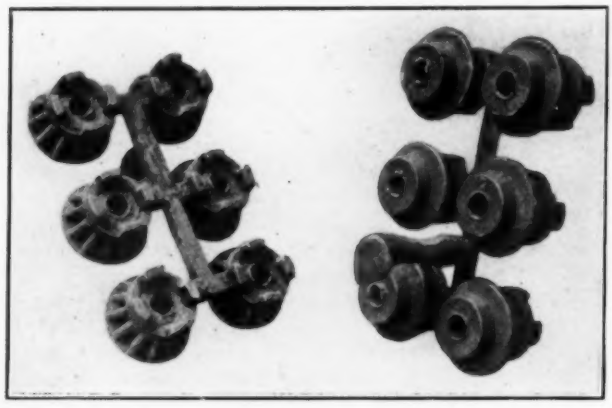


FIG. 1. THE CASTINGS

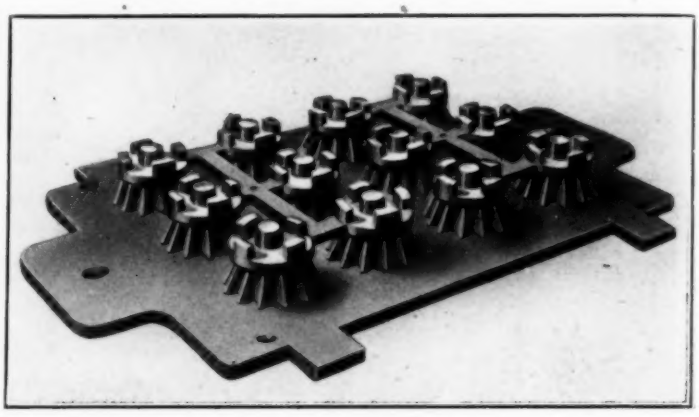


FIG. 2. PLATE PATTERN

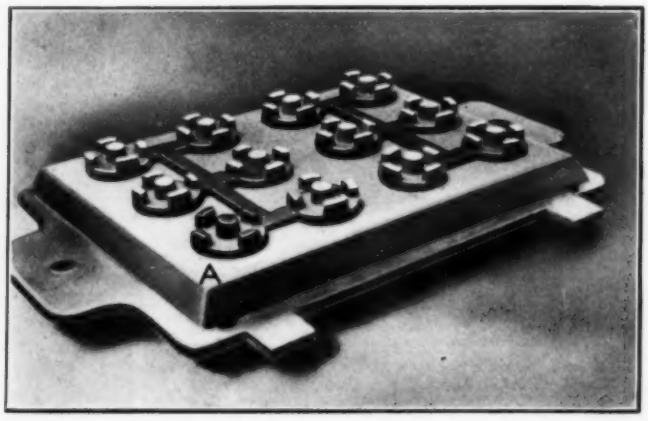


FIG. 3. PLATE WITH JOINT-FORMING FRAME A

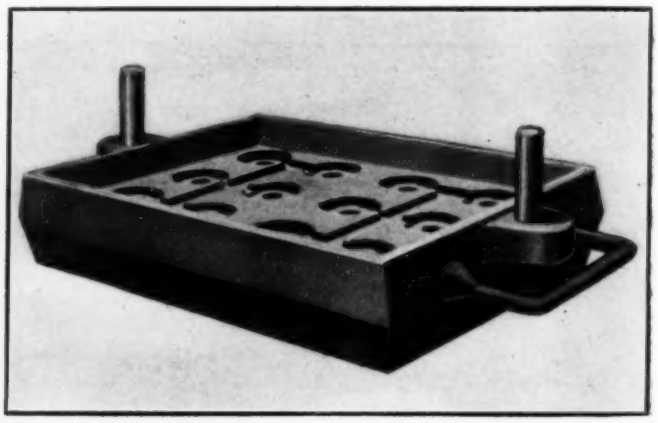


FIG. 4. DRAG PART OF MOLD AND FLASK

The Patterns for the Cheek and Drag; Method of Molding the Drag.

The method of molding is to place the frame *A* in position, as in Fig. 3. This frame is located by pins in the frame and holes in the pattern plate, not shown. This frame has twelve holes in its top side, which allow the pinions to project through the thickness of the metal in the frame, so that the top of the frame and the tops of the pinions are level. The clutches, which are shown in position, conceal these holes, the clutches being of considerably larger diameter than the pinions.

The drag part of the flask is placed on the plate and fine facing sieved on, the mold rammed and struck off level with the top of the flask; the plate is next rapped and the flask lifted carefully from the pattern, or the plate and flask may be turned over and then the plate lifted away and the patterns—two sprays—drawn separately. A number of drags are first rammed, say 12, and stacked on edge close together.

Molding the Cheek

The plate is now prepared for the middle part, as shown in Fig. 5. The frame *B* is located in the same way as frame *A*. Facing sand is sieved and tucked around the patterns and the sand struck off level with the top of the frame, and the frame lifted off, which leaves the mold as in Fig. 6. One of the drag parts is next placed over the middle on to the plate, and the whole turned over, and the plate rapped a little and drawn; the cores are then set, leaving the mold, as in Fig. 7, the top part being, of course, formed on the back of the plate (not shown).

September 23 has been set apart as "Robert Fulton Day" at the Jamestown Exposition, when will be celebrated the centennial anniversary of the first voyage up the Hudson of Fulton's steamboat "Clermont." The actual date when the trip was begun was August 1, 1807.

The Unnecessary Ordering of Special Machinery

By W. F. Sears

Experience along this line would tend to show that in a great many instances special machines are ordered and built, at heavy expense both for the original designing and building and the later experimental work, where some standard tool could readily have been adapted to the purpose if this tool had been given proper consideration and its range of work thoroughly gone over.

There are undoubtedly many instances in which a company is engaged in the manufacture of some regular line or lines in large quantities, where a special machine built from the foundation up and practically new in every way is not only a warranted expense but an actual necessity. Fortunately for the machine-tool business, however, such companies and their special lines are few compared with those in which standard tools or tools with slight alterations are economical and efficient. If this were not the case there would probably be but little development in machine tools.

Adapting Standard Machines to Special Work

In a great many instances it will be found that while a tool of some regular type is not, as it stands, properly adapted to the work to be done, a fixture or slight alteration or addition can be made to the machine which will solve the problem in a most satisfactory manner and, in fact, many times give results in advance of what could be obtained from a special machine throughout, with the natural weak points of a first design.

While this article is not intended for other than a general one, a specific instance which lately came to the writer's notice may serve to illustrate the point in discussion in a much better manner than any discussion along general lines.

Where $2000 Could Be Saved

An inquiry was received for a special machine for doing large quantities of a certain class of work which, at first sight, seemed to demand a complete special design throughout. An estimate was made which showed that the cost of this special machine would not be less than $7000, and it is doubtful if a shop would have come out whole even at this figure. In addition, there was no guarantee from former experience that the machine would be right in all respects, and the delivery was also far from satisfactory.

As this was somewhat discouraging, the matter was further investigated, and the different lines of tools carefully looked over, with the result that an alternative proposition was put in for a standard machine which would handle the work in a quite different manner from that originally intended. This machine was regular in every way, its performances known, and therefore there was no doubt raised as to its ability to perform the work desired. In order, however, that it might handle the new class of work to advantage, a fairly elaborate fixture was required. The price of the machine was about $4000, and of the special fixture not over $1000.

Better Than the Special Machine

There was no question but that, with the aid of the special fixture, the machine would equal if not beat the proposed spe-

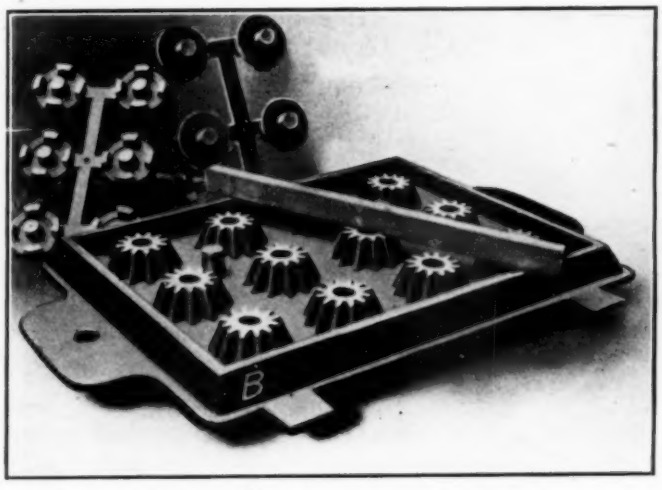


FIG. 5. PLATE WITH FRAME PREPARED FOR MOLDING MIDDLE PART

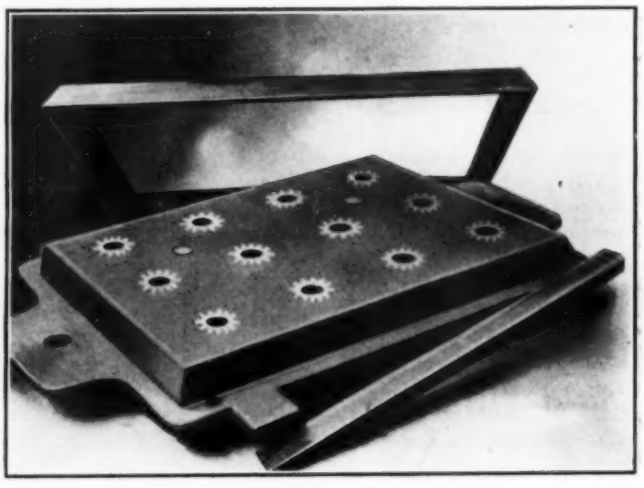


FIG. 6. PLATE WITH MIDDLE PART RAMMED AND FRAME REMOVED

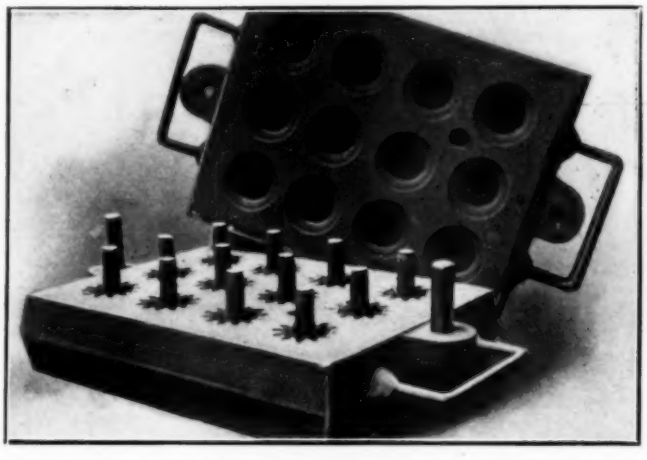


FIG. 7. MOLD OPEN WITH CORES SET

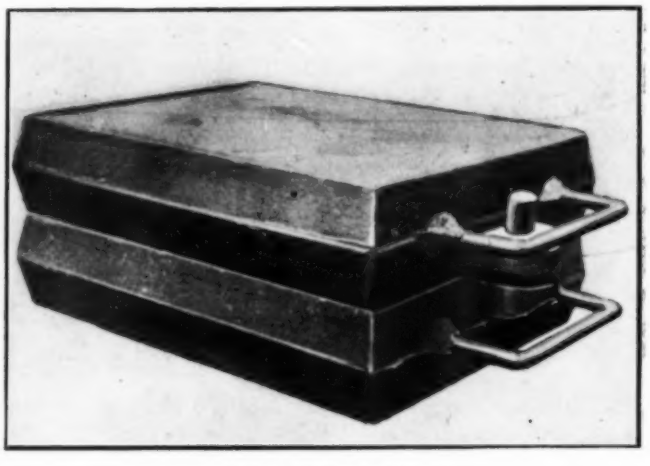


FIG. 8. MOLD CLOSED

cial machine and, furthermore, the design of the fixture itself was a much less troublesome piece of work than the design for a whole machine, and the results much more likely to be satisfactory in every way. Thus, with practically no alteration, we furnished a machine which, as regards handling and finishing the work, is in every respect equal to the special machine, even supposing the latter was the full success hoped for. The fixture, which is to be built by the company purchasing the machine, will be one along lines with which they already are somewhat familiar, and the total price and the time of delivery are much more satisfactory.

It will be seen that four-fifths of the price paid by the purchaser is thus put into a machine for which he is sure to get full value, and the only risk he runs is on the remaining one-fifth or $1000, and the percentage of risk on this is less than the percentage on the $7000, supposing he were to insist on the special machine.

Convincing the Purchaser

This matter of special tools is one that is continually cropping up, and is one that should be most thoroughly investigated before any final decision is reached. The chief trouble experienced by the writer has usually been in convincing the purchaser that the results given by the standard machine will be equal, as far as quantity and finish of work turned out are concerned, to a machine which is special throughout, for it often happens that strong inclination or prejudice for a machine special in every way exists, and this feeling is often somewhat hard to overcome. In most cases, however, the appeal to the pocket-book and common-sense is so definite and great that not much difficulty is met with.

A Suggestion to Buyers

The suggestion is made that questions along this line from manufacturers should be submitted to builders who handle or make a large number of lines and who are familiar with the capabilities of them all, as it very often happens that the machine finally decided upon as best for the purpose is quite a different one from what was originally in mind, both as regards method of handling and method of finishing the work; and the greater the range of tools the bidder is acquainted with, the more chances there are that the tool best for the purpose will be selected. There is also much less reason for there being any prejudice for one class of tool as against another in making the estimate.

Of course, special tools and machinery will always be demanded; but the purpose of the above article is an endeavor to show that special work does not always demand special and expensive machinery throughout, and that any class of work made in large quantities can often be cheapened in its production by special fixtures or very slight alterations to tools of standard make.

The outcome will usually be most satisfactory and the expectations very closely met, owing to the thorough previous knowledge of the machine or machines used, and, finally, the chances of failure are reduced to a minimum.

Helping Mrs. Machinist Cook Your Dinner

By R. E. Marks

The Mrs. has been sort of getting spring fever lately in spite of the cold spell, and I got to wondering if there wasn't some way I could help her out beside wiping the dishes after dinner. I had rigged up an alarm clock to turn the drafts on the furnace at any time I wanted, in the morning, so I didn't have to get up and go down cellar in the cold at 4 a.m., as formerly. But there didn't seem to be any automatic way of helping the Mrs. till I ran across the hay-box idea in an army report. There wasn't any great amount of enthusiasm at home when I started in, because hay reminds one of sensitive nerves very forcibly of a stable instead of a kitchen, but it won out in the end.

There wasn't a place in the kitchen I could think of for it to go, but under the sink, so I made it to fit, put on good-sized casters, handles in front to pull it out by and it was handy in every way.

The illustration shows how it looks pulled out and with the two end compartments open. The whole thing is 42 inches long, 16 inches deep, 15 inches wide, and is divided into three compartments, so that the Mrs. can cook potatoes in one, corned beef and cabbage in another, and Brown Betty pudding in the end. So the Mrs. starts her dinner on the gas stove, gets the various things to the boiling point, claps them in the hay box, shuts down the covers, takes the kidlets out to the park and only needs to get home in time for supper.

There is nothing mysterious about it. Get the sized pails you need with tight-fitting covers, get a soap box, or make one, as I did, about four inches larger each way than the pail. Put in four inches of hay at the bottom, set in the pail and pack hay all around it so as to make a nest. Have a pillow of hay or anything else that is a good non-conductor to put over the top. Then when the potatoes have boiled five minutes on the gas stove, put the covered pail, boiling hot, into the nest, put on the pillow, shut the cover and lock it tight. I use padding on the cover to make a tight joint and window fasteners that draw the sashes together, to lock the lids shut.

THE HAY-BOX OR FIRELESS COOKER READY FOR USE

It works on the same plan as your refrigerator, which keeps the heated air away from the ice while this keeps the cooler air away from your boiling dinner.

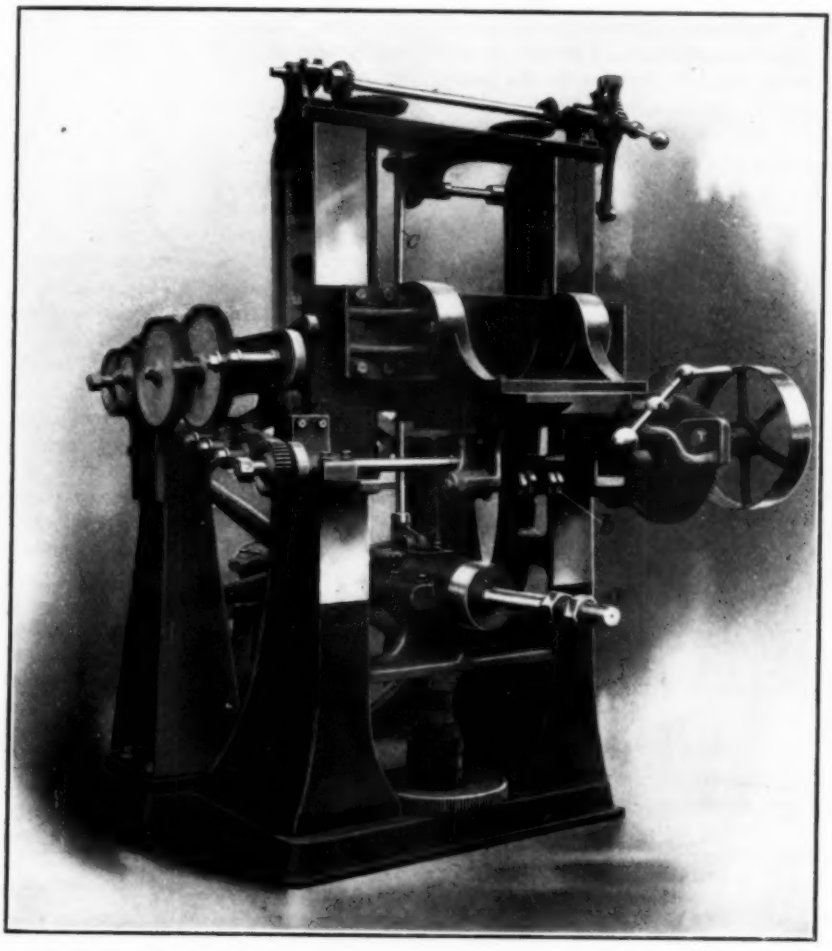
The beauty of it is that the Mrs. can start the dinner going in the morning, we can all go out to the park or up the river for the day, and know that the dinner will be practically ready to put on the table when we get home. That makes all the difference in the world about enjoying an outing of this kind.

Different things require longer or shorter boiling periods, but it doesn't pay to do your own experimenting when you can buy a cook book made specially for this for 50 cents, and lest you should hesitate at the work of making the box, let me tell you something that will touch your pocket-book nerve—it saves about four-fifths of the gas required to boil potatoes, oatmeal and other things that you cook by boiling. You can't let anything burn on the kettle, if you happen to forget it, and you can use it to keep meals hot for hours either at home or in the shop. The Mrs. wants me to use one in the shop.

The Original Hindley Worm Cutting Machine

EDITORIAL CORRESPONDENCE

The accompanying illustration shows the first machine to be constructed for the commercial production of Hindley worms and worm wheels. Prior to the construction of this machine the Hindley worm was little more than an academic curiosity. It was shown in a diagrammatic way in text books on mechanism and model worms had been made by means of extemporized apparatus, but it had not entered into commercial practice. The machine shown



THE ORIGINAL HINDLEY WORM CUTTING MACHINE

was built in 1882 by S. A. Morse, who was the founder of the Morse-Williams Elevator Company. As an original machine, it was a bold piece of work, its capacity being equal to the cutting of wheels 40 inches in diameter by 2 inches pitch and it has produced a great number of these worm gears, many of which are still in operation. The machine has now been out of commission for about 15 years, but the growing necessity for room in the Morse-Williams factory has compelled its demolition, prior to which the accompanying photograph was made as a memento of the beginnings of the business.

While entirely unlike present-day machines in general appearance, its principle is precisely the same, it being essentially the modern machine turned on end. The worm blank being cut was mounted on the lower horizontal spindle *a* which was driven by the master wheel at its rear end. The hob was mounted on the arbor *b*, driven by the gears and belt pulley shown. The necessary connection between the two arbors was obtained by means of the change gears at the left of the machine, while the feeding of the worm toward the wheel shaft was obtained by means of the vertical shaft *c* which, through the bevel gears and the ratchet feed at the upper right-hand corner of the machine, drove the vertical screws between the frames and thus gradually forced the hob toward the wheel blank. A crank handle *d* provided for the adjustment of the hob centrally with the wheel blank. F. A. H.

Spontaneous Ignition of Coal

The old hypothesis suggested by Liebig, according to which the spontaneous inflammation of coal is due to the oxidation of the pyrites, can no longer be maintained. Spontaneous ignition, according to the German scientist, Dr. Heideprim, would seem rather to be attributable to a direct oxidation of the carbon. In fact, carbon when heated has been found eagerly to absorb oxygen from the air, and this heating effect can be increased until ignition occurs. The part played by moisture in the process has not yet been determined. The physical conditions of the carbon (hardness, size, etc.) are other factors influencing the process. In connection with a recent investigation of 300 cases of self-ignition, all kinds of mineral coal apart from anthracite were examined. In most cases the ignited coal was ordinary coal, and less frequently nut coal or coal dust. The higher the layers, the more readily will self-ignition take place. An efficient ventilation by channels in the coal layers and the thermometrical recording of temperatures by long thermometers inserted in the coal have been found to be good preventive measures, while the only available means of extinguishing such fires has been found to be a transfer of the coal and simultaneous flooding.—*The Steamship.*

An indication of the attention which is being directed toward the use of concrete is found in a paper read by the telegraph superintendent of the Pennsylvania lines west of Pittsburg, before the Association of Railway Telegraph Superintendents, in which was given the results of experiments on telegraph poles made of reinforced concrete. These poles have not yet received extended test in service, but the results of experimental tests are promising, and it is quite possible that the drain on our forest resources for telegraph poles may be largely reduced in the near future.

The British report from the oil fields in the Baku district of Russia is to the effect that steam turbines have lately come into use for driving electric dynamos and for pumping installations. They have also been tried with some success for driving the drilling rigs and baling drums in wells. Their chief object, it is stated, besides a slight economy in steam over the ordinary engine, is their compactness and the comparative ease with which they can be removed from one well to another.

Planetary Gearing Solutions

By John E. Sweet

Some weeks ago you published an article dealing with the question of planetary gearing which to the mathematician no doubt will be a help in figuring out gears of that kind. As all men who have to design this form of gearing may not be mathematicians I have thought easy ways stated in plain English would be a help to these people also.

Take first a plain planet and revolve it on the inside of an internal gear (Fig. 1). In this case the planet will always make one less turn than that indicated by its diameter or number of teeth. If the planet is half the diameter of the internal gear it will make but one turn; if one third the diameter, two turns; if one quarter, three turns, etc. I have never known but one case where this was used.

In the form shown in Fig. 2 the planet will make one more turn than indicated by the diameter or number of teeth. If the two gears are of the same size the planet will make two turns; if the central pinion is twice the size of the planet it will make three turns; or if three times the size, four turns, etc. I have never seen this form used.

The form shown in Fig. 3 is the most common form and is used to both multiply and reduce the speed. With the internal gear fixed and the central pinion rotated as a driver to reduce the speed, the planet turning on a stud in a spider, the pinion will have to make one more turn to drive the planet completely around its orbit than the direct relation between the pinion and internal gear; or if the planet is made the driver it will give the pinion one more turn than the ratio between the pinion and internal gear; that is one more turn than if the planet were an idler, and the internal gear a driver. If the pinion is one third the size of the internal gear the ratio of the speeds will be 4 to 1; if one-half, 3 to 1; or if one-fourth, 5 to 1, etc.

The form shown in Fig. 4 is used not infrequently and is best known perhaps in the Yale & Towne triple-geared pulley block, in which the planets are wheels and pinions fast together. To figure this it is only necessary to combine the two features before explained. Let the central pinion be one half the size of the planet gear, and the planet pinion one fourth the size of the internal gear, as shown in the cut, Fig. 4. Then as demonstrated before the planet pinion will make but three turns in going around; and the planet gear going around the central pinion will make it turn three times also; hence 3×3 gives 9 as the result. All this to show that when the various gears are divisible one by another there is no trouble about figuring them except to deduct one or add one turn, or both, which ought not to require even a pencil and paper to make the computations. When the ratios are not divisible one by the other the thing becomes more confusing, and the graphic method is simpler.

Take the case of Fig. 3. Let the line A Fig. 5 represent the distance (at as large a scale as convenient) from the center of the system to the pitch line of the internal gear or BC. Let the distance B to D represent the radius of the pinion, and C to F the radius of the planet (all to the same scale) strike the verticals, and draw the diagonal G at any convenient angle so that the distance from c to d is some convenient unit. Draw the other diagonal from C to intersect the line G at H, now as the distance c to d is to c to c so is the speed ratio between the pinion and planet.

Fig. 6 shows a similar diagram dealing with the condition in Fig. 4. The line from A to B represents at an enlarged scale the distance from the center of the system to the pitch line of the internal gear; from A to C the radius of the central pinion; from B to D the radius of the planet pinion; and from D to C the radius of the planet gear. Strike the two diagonal lines as before; E from the center of the pinion at any convenient angle; F from the pitch line of the internal gear, so as to intersect the other at the crossing of the vertical line from D. And now as the distance from the point C to c is to the distance from C to d so will be the relative speeds of the central pinion and planet in its orbit. Or in other words

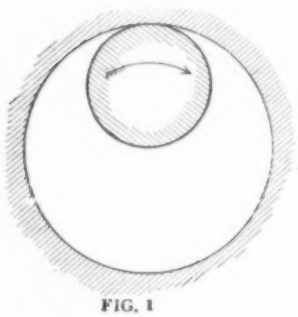


FIG. 1

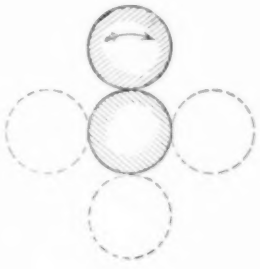


FIG. 2

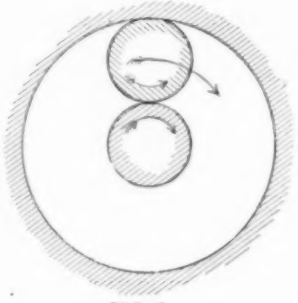


FIG. 3

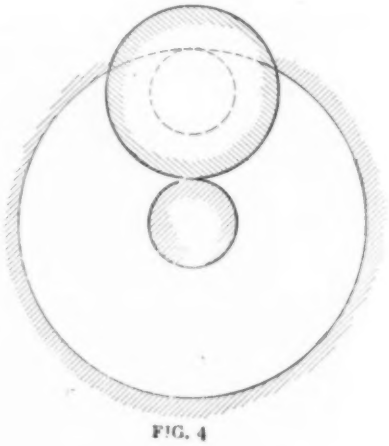


FIG. 4

PLANETARY GEAR TRAINS

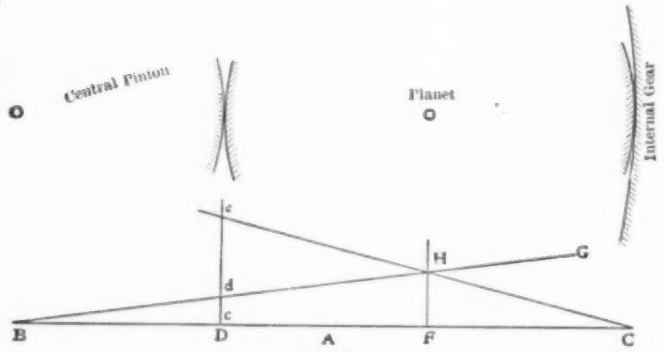


FIG. 5

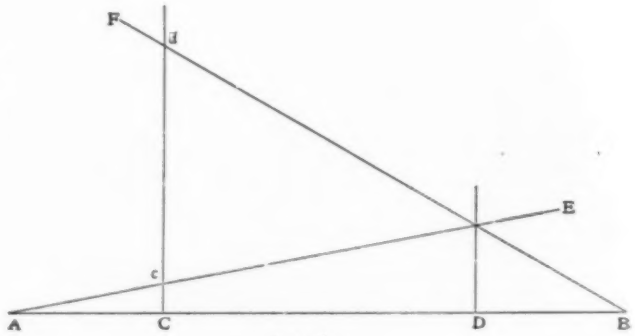


FIG. 6

GRAPHICAL SOLUTIONS OF PLANETARY GEARING PROBLEMS

the difference in speed between the two shafts.

Planetary gearing for both gaining power and speed are more compact than common spur trains, when two or more planets are used, better than such gearing as the ordinary back gear of a lathe; because the two planets drive from two points without making the bearing one of the driving points. It is another application of the principle embodied in the two-tailed dogs.

More about Vanadium Steel *

By J. Kent Smith

Before I speak of vanadium itself, perhaps you will allow me to say just a few words on the subject of steel from an engineering standpoint. Under the conditions of practice comparatively few years ago we were accustomed to judge with considerable success the steels that we had by their behavior under static tests, that is to say, under tests where the force and the body were more or less at rest, or, anyway, very slowly moving. We had a rough kind of an idea that anything that gave certain static tests would behave in a certain way in use. But as things have progressed, our point of view has changed in regard to this somewhat. A body may be perfectly statically ductile and a body may be perfectly susceptible to satisfactory static tests, and yet when you apply stress tests dynamically (hit the body or vibrate it, or anything like that), it goes to pieces or something happens. As the conditions of engineering requirements got more drastic, we began to have more and more failures which we were acustomed to call "mysterious" failures. Of course, a few of the cases of failure were not mysterious, because the metal was obviously of bad composition; but in very many cases the metal would give perfectly good tests chemically and statically; it might even look perfectly well under the microscope, yet it had broken. The fact of the matter was, it practically got tired of its work and had "thrown up the job."

Effect of Repeated Strains

I think it is beyond argument that we can break a piece of metal by applying repeated strains less than its elastic limit. For instance, supposing we take a piece of metal the elastic limit of which is represented by any number as 10. Now, if we put a series of strains on that metal, each of whose intensity is only represented by the number 5, in due time we will fracture it. If such strains be only represented in intensity by the number 2½, we will in time fracture the metal, but in an interval of time much greater than twice that accompanying the first set of conditions. In other words, all steels deteriorate under repeated strains, and such deterioration is enormously more rapid as those repeated strains approach the elastic limit of the steel. *But such rate of deterioration is not proportionate in different steels,* and it is precisely here that the very great value of vanadium comes in, as the vanadium steels have proved themselves, both by test and in practice, to be absolutely pre-eminent in their power of resisting such deterioration.

The usual dynamic tests include a sweeping shock on a notched bar, repeated blows by a falling weight on either a notched or an unnotched bar, rapidly alternating impacts accompanied by permanent distortion on an unnotched bar, and rotary vibratory flexion tests produced by the suspension of a counter-weight on a rapidly revolving bar of such shape that the area of fracture is definitely located.

A Master Alloy

Vanadium thus can be regarded as a "master" alloy, in that it can act in totally different ways, and by judiciously using it in the line one wishes to follow, steels of great dynamic superexcellence, great static superexcellence, or combinations of both, are attainable, such as can be obtained by *no other known means.*

The second table illustrates types of this.

The "vanadium axle steel" should be of particular interest to railway engineers, as the attainment of a steel statically comparable with a nickel steel (in fact, superior to it, even statically), combined with the ductility of mild steel and an infinitely greater power of resisting fatigue, as evidenced by vibratory and alternating impact tests (such inference, I may say, is amply borne out by practical experience), puts a new phase on the "factor of safety" question in connecting rods, coupling rods, crank-axles and the like.

Rolled Bars Untreated.	Lbs. per □" Elastic Limit.	Ultimate Tensile Stress.	Elongation on 2 ins.	Reduction of Area.
	Tons per sq. in.	Tons per sq. in.	Per cent.	Per cent.
Crucible steels:				
Plain carbon-manganese	35,840	60,480	35	60.0
Plain + 0.5 per cent. chromium	51,296	76,160	33	60.6
Plain + 1.0 per cent. chromium	56,000	85,568	30	57.3
Plain + 0.1 per cent. vanadium	63,840	77,952	31	60.0
Plain + 0.15 per cent. vanadium	68,096	81,760	26	59.0
Plain + 0.25 per cent. vanadium	76,384	88,032	24	59.0
Plain + 1 per cent. chromium + 0.15 per cent. vanadium	81,088	108,864	24	56.6
Plain + 1 per cent. chromium + 0.25 per cent. vanadium	90,496	135,296	18.5	46.3
Open-hearth steels:				
Plain carbon-manganese				
Plain carbon + 1.0 per cent.	39,648	72,128	34	52.6
Chromium + 0.15 per cent. Vanadium	77,056	116,480	25	55.5

TABLE I. COMPARATIVE EFFECTS OF CHROMIUM AND VANADIUM ON STATIC TESTS

Rate of Deterioration

The rate of deterioration before alluded to as to repeated stresses become less severe as is amply illustrated in Table 1.

I strongly advocate also that the usual static "tensile and bend" tests should, in many cases, be supplemented by the knowledge of the behavior of the steel under torsion, while I attach great importance to the repeated bend test made in such a way as to indicate the point at which the metal begins to "break down." In those respects the vanadium steels take the front rank.

The action of vanadium is very powerful; it may be said that vanadium is to metallurgy what strychnine is to medicine, and therefore it is only used in small quantity.

Vanadium increases the strength of steel *per se,* but to the greatest extent by acting through another constituent (present in such quantity as not to dynamically "poison" the steel in question), while it confers in itself to steel properties of great dynamic value. The first is exemplified by the Table.

Vanadium Spring Steel

In another grade comes vanadium spring steel, which has proved of enormous value, not only in enabling a spring to be made having twice the coefficient of safe working load (and thereby rendering possible the lightening of the spring itself), but at the same time one which is, so to speak, endowed with the property of "life" and does not "get tired" and break down as a pure result of service. Again, the value of such a spring is great in regard to the fact that it can safely meet "overload." I am sure this spring steel is a matter that has some interest to railway engineers.

The subject of case-hardening is a fascinating one, and one that could with justice occupy half a dozen lectures itself. In a lecture such as this it would be impossible to go into detail. Suffice it to say, therefore, that no *tempering steel* should be case-hardened, owing to the inevitable brittleness produced in the core through the necessary operation of quenching. A special variant of vanadium steel is made

*Extracts of a lecture by the chief metallurgist of the American Vanadium Company before the Central Railway Club, Buffalo, N. Y.

for this process, utilizing the toughening action of vanadium on a quenched high carbon steel and the conferring of strengthening and fatigue-resisting qualities to the core of the article, thus enabling a result of wonderful value to be obtained.

Vanadium case-hardening steel stands on record as the finest material of its kind, as the result of very great numbers of practical experiences.

Its Use in Castings

Vanadium has been very successfully used in castings. It is not advisable, from a practical steel-founding point of view, to use chrome in a "casting." We use plain vanadium, and we anneal the casting at about 950 degrees Centigrade. Then you will get a casting which, in resisting vibration, is very much like a good type of forged carbon steel; it is infinitely superior to the ordinary carbon steel *casting*. Of course, the ordinary steel casting in carbon does not stand vibration like forged carbon steel, but the vanadium steel *casting* will stand it like a carbon steel *forging*, while in its use in casting we are getting a combined static and dynamic action out of it. We are increasing the static strength considerably, if not to the fullest extent, while we are increasing the dynamic qualities enormously. We use it in casting chiefly with a view of increasing "dynamics" and not "statics." I may seem to be a kind of a maniac on dynamic tests, but their importance has been borne on me so often in ordinary work. There is no doubt about one thing—you cannot adduce dynamic qualities from static tests any more than you can do the other way about; they are in two totally "different streets," to use an everyday expression.

Vanadium steels are no more difficult to forge than the ordinary corresponding steels. The only word of warning I would sound here is that vanadium steels must be treated as high-temper steels. That is to say, we must not go and plunge the heat into it all at once. Vanadium structural steel forges exactly like a 3½ per cent. nickel steel. If you apply the heat and work to it at first reasonably gradually you will have no trouble afterward. The steel will stand as much heat as mild steel, but in heating any steel of high temper you are very liable to disintegrate the metal and you have to observe reasonable care and precaution. As regards the maximum contents of vanadium I have found myself, from experience, it is very seldom advisable to go above 2 per cent.; certainly never above 25 per cent.

Locomotive Frames

There is no doubt in my mind that the chief difficulty at present existing in the locomotive frame is the resistance through molecular disintegration. If we use vanadium there we cure it; there is no question about it. That has been a shining example of where "dynamics" came into play, almost exclusively; it is almost simply and solely a question of resisting vibratory molecular deterioration. Actual trials at the present moment are in progress with vanadium on the very subject of locomotive frames.

I hope that I have not given the wrong impression. I have harped so much on the question of dynamics to the seeming exclusion of statics. Do not think that I am sneering at the static tests or that I apparently dismiss the value of high static strength and ductility. I do not. I attach great importance to them. But I speak from experience when I say that I am sure that we were beginning to lose ourselves in straining to get a high static strength that we really *did not want*, at the sacrifice of something that we *did want*, and therefore, that we would have been better off if we had gone less for increased static strength and increased our dynamic qualities.

Nature.	Tests.	1 Carbon "Axle" Stock.	2 Nickel "Axle" Stock.	3 Vanadium Axle Steel.	4 Vanadium Crank-shaft Steel.	5 Vanadium "Continual Mesh" Gear Steel.
Static	Yield point (lbs. per sq. in.)	41,330	49,270	63,570	110,100	224,000
	Ultimate stress	65,840	87,360	94,080	127,800	232,750
	Ratio	0.62	0.56	0.66	0.87	0.96
	Elongation % on 2"	42	33%	33	20	11
	Reduction of area	61%	58%	61%	58%	39%
	Torsional twists	2.6	33	4.2	2.5	1.8
Intermediate	Alternating bends	10	12	18	10	6
Dynamic	Resistance to pendulum impact (foot lbs.)	12.3	14	16.5	12	6
	Alternating impact, number of stresses	960	800	2,700	1,850	800
	Falling weight on notched bar, number of blows	25	35	69	76	.....
	Rotary vibrations, number of revolutions	6,200	10,000	67,500	.....	.....

TABLE 2

N. B.—All figures obtained *under* comparative conditions.

Automobile purposes are taken owing to requirements of same being of the most exigent nature.

Relation between Process of Manufacture and Some of the Physical Properties of Steel *

By F. W. Harbord

For many years it has been known to all steel manufacturers and metallurgists that steels made by different processes, although practically of the same composition, varied in their tensile strength, hardness and other physical properties, and it has been generally admitted that basic bessemer steel was softer than acid bessemer, and basic siemens softer than acid siemens. So far, however, as the author is aware, no systematic experimental results have been published defining with any exactitude these various differences over a wide range of carbon content. Campbell, in his well-known book, gives the results of a large number of experiments on basic open-hearth and acid open-hearth steel, but he does not deal with steels from the two bessemer processes. Until comparatively recently, high carbon steels, with the exception of some basic bessemer rail steel, have been made almost exclusively by the acid open-hearth or acid bessemer process, at all events so far as this country is concerned, and consequently the physical properties of high carbon basic open-hearth steel for general engineering requirements have been of comparatively little practical importance.

In view, however, of the recent developments of the manufacture of high carbon steels in the basic open-hearth for rails and various other purposes, together with standardization of our British specifications, the question of how far steels of similar chemical composition, but made by different processes, will vary in physical properties, and how far the specifications should be modified to meet them, becomes of importance both to manufacturers and to engineers.

To obtain, if possible, some reliable data on the physical properties of the steels produced by different methods of manufacture, the author obtained a large number of bars, rolled as far as possible under the same conditions, from approximately the same sized ingot and to the same section, and varying in the percentage of carbon from about 0.10 to 0.75 per cent. These bars were subjected to a preliminary examination for carbon and manganese contents, and any bars exceptionally high or low in manganese were rejected until about 53 bars of approximate similar composition for a *given carbon content* were finally selected for complete analysis and the various mechanical tests. The bars were all tested for tensile stress

*Abstract of a paper presented to the Iron and Steel Institute.

by Brinell's ball test for hardness and by different methods of impact testing, in the rolled condition and after heating to a temperature of 620 degrees Centigrade. The results obtained with these experimental bars were supplemented by a very large number of results which the author has been able to collect over a series of years, and also by a large number of results

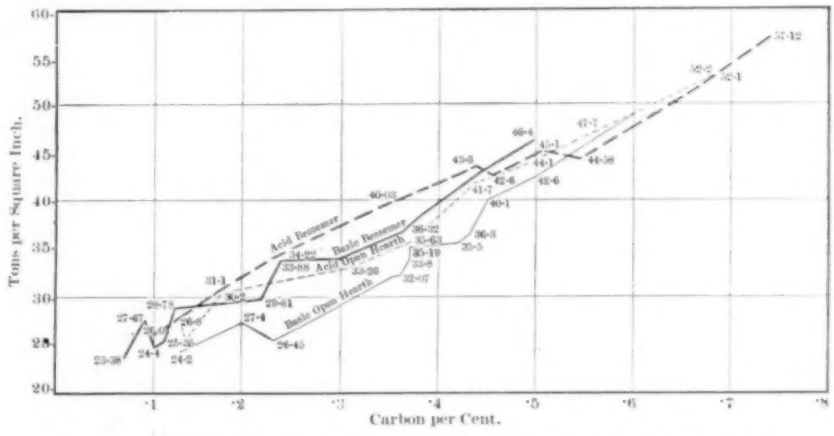


FIG. 1. ULTIMATE STRESS. EXPERIMENTAL BARS HEATED TO 620 DEGREES C.

most kindly supplied by various manufacturers and engineers, as the result of their daily experience.

Owing to the large number of variables, such as the variation in elements other than carbon, size of ingot, size of section, finishing temperature, etc., it is not suggested that the results given are scientifically accurate; but it is hoped the results obtained from the experimental bars, taken together, with the average results collected from various sources, will approximate to accuracy sufficiently for all practical purposes.

The reheating temperature of 620 degrees was selected as being below the carbon change and yet sufficiently high to remove any irregularities due to finishing temperature of rolling. The results are plotted in curves (Figs. 1 and 2), and show diagrammatically the relative tensile strength of the four classes of steel. It will be seen that acid bessemer gives the highest tensile stress, basic bessemer the next, acid open-hearth comes third, and, as might be anticipated, basic open-hearth steel gives the lowest results.

Considered as a whole the results are as regular as could be expected, when allowance is made for all the variables. It is somewhat surprising to find that the irregularities are greater in the case of the reheated samples than in the case of the samples as rolled, as every precaution was taken to insure equable heating, the samples being maintained at a temperature of 620 degrees Centigrade for 20 minutes after they had reached a constant temperature.

The percentage of manganese in all the series is generally lower for the lower carbon than for the higher carbon steels, but for the same content of carbon the manganese is approximately the same; this remark does not apply fully to the acid and basic open-hearth samples, where the manganese is generally lower throughout than in the bessemer steels, and probably had the manganese been 0.10 to 0.15 per cent. higher, the curve for this steel would have been generally raised, possibly 0.5 of a ton. Side by side with these curves are plotted curves (Fig. 3) obtained by taking the averages of the results obtained from a number of steels in my possession and collected from manufacturers and others both in this country and abroad. In plotting these curves the steels were divided into various groups, according to their managanese content, and for steels up to 0.3 per cent. carbon only those with less than 0.7 per cent. of manganese were used. For higher carbon steels the manganese varied from 0.7 to 0.9 per cent. to enable a large number of rail steels to be included, but for the same percentage of carbon the various steels may, as regards chemical composition, be regarded as comparable.

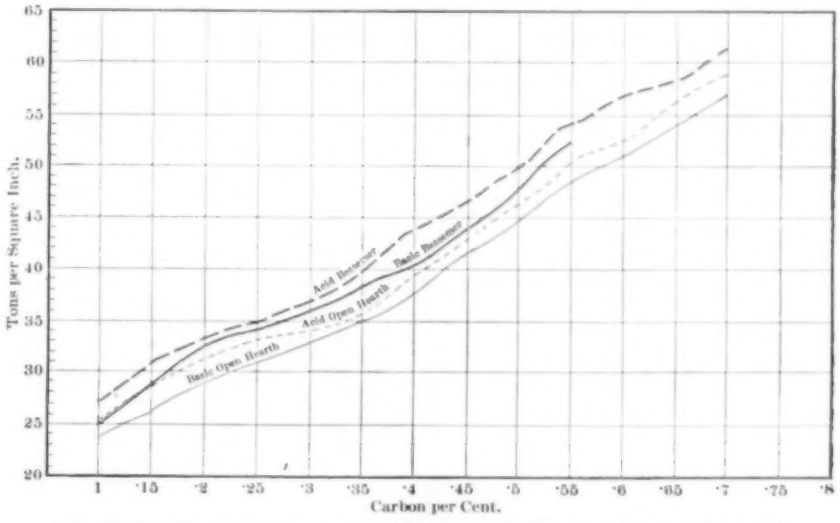


FIG. 3. ULTIMATE STRESS. AVERAGE OF A NUMBER OF RESULTS AS ROLLED

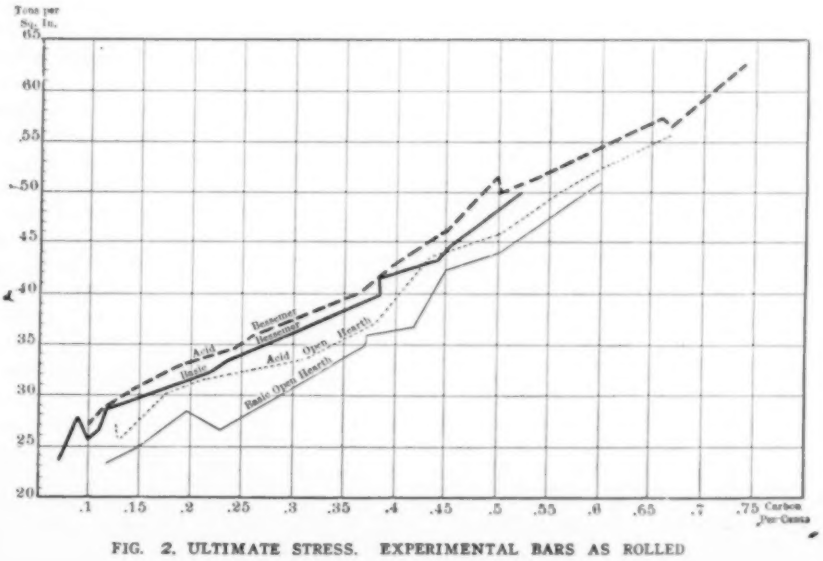


FIG. 2. ULTIMATE STRESS. EXPERIMENTAL BARS AS ROLLED

The same general order is preserved among these steels as in the case of the experimental bars; but, as might be anticipated, there is less irregularity, the numerous variables likely to affect the tensile stress and other properties being spread over a much larger number of samples.

The elastic limits, elongations and re-

ductions in area have not been plotted in curves, as, generally speaking, they compare with the tensile tests, and there is no point in increasing the number of curves, a practice liable to lead to confusion. The ratio of elastic limit to ultimate stress is somewhat variable, and the data available hardly justify any deductions as to one class of steel being better than another in this respect.

Lead and Pitch of a Screw—What They Are

By Oscar J. Beale

If a screw is to be more than one turn to an inch, in ordering it to be threaded be sure to tell the *number of turns to an inch.*

Many years ago, in conversation with a well known lathe maker, he told me of a lead screw that he had spoiled in threading because the order had not been understood in the way meant by the man that wrote the order. It struck me as very strange and disturbing that in all the ages since screws began to be used men expert in the making and in the using of them had not been able to understand one another.

If an order is sent into the machine shop for an 8-pitch screw, probably no mistake will be made in filling it; probably what is wanted is eight turns of the screw to advance a nut one inch, and eight threads to one inch; but if an order is for a 1½-pitch lead screw, the machinist may decline to thread the screw without plainer instructions; or, if he thinks he understands and goes ahead with his threading, he may have thoughts similar to those of the lathe maker when he was telling me of his spoiled lead screw.

When a screw advances a nut somewhat near to one inch in one turn of the screw, the old way of expressing is not clear; thus, we should require some explanation if ordered to thread a screw 1½ pitch, because it is not quite certain whether it is to be one and a half turns to an inch or one and a half inches to one turn; and so, even in talking of a single-threaded screw, men have not understood one another. This misunderstanding has probably existed since Archimedes was a boy, and perhaps long before.

If a machinist is told *how many turns to an inch* he is to thread a screw, he will know at once how to figure the change gears for his lathe. Now, if he is also told *how many threads* the screw is to have, that is, whether single-threaded or more, he will know how to select his threading tool. If the lathe maker had been told how many turns to an inch to thread his screw, and also how many threads, I think his screw would not have been spoiled.

If a screw is to be *less than one turn to an inch,* in ordering it to be threaded, it is generally convenient to tell the number of inches the thread advances in one turn of the screw.

Change gears for screws, or spirals, cut in most universal milling machines, are figured from a basis of ten inches to one turn of the spindle, which is more convenient than to figure the machine as one-tenth turns to an inch.

About nineteen years ago Messrs Brown & Sharpe, in order to avoid mistakes in the reading of drawings, decided to designate the advance of a screw to one turn as the *lead.* It is now the only term they ever use to designate this advance. *The turns to an inch* are obtained by dividing one inch by the *lead.* Conversely, the quotient of one inch divided by the *number of turns to an inch* is the *lead.* In other words, the product of the *lead* multiplied by *the turns to an inch* is always equal to *one inch.*

The term pitch has been limited to designate the distance between two consecutive threads or between two consecutive teeth. Divide one inch by the pitch and the quotient will be the threads to an inch. Divide one inch by number of threads to an inch and the quotient will be the pitch.

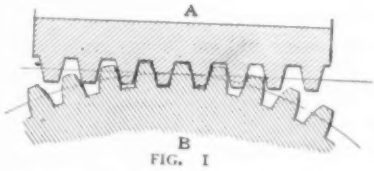


FIG. 1

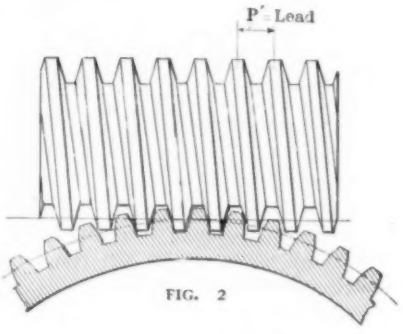


FIG. 2

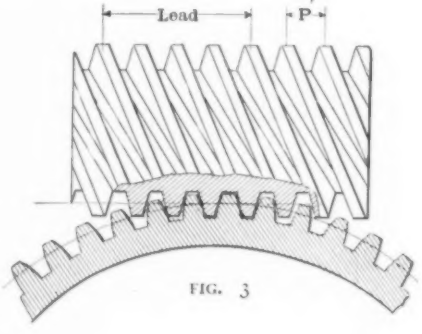


FIG. 3

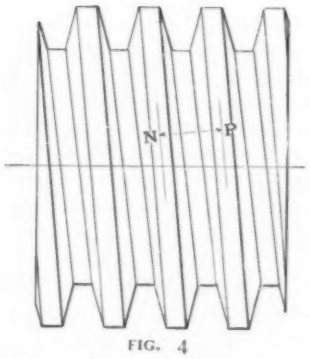


FIG. 4

LEAD AND PITCH OF A SCREW

The product of the *pitch* multiplied by the number of threads to an inch is always equal to one inch.

In the American Machinist for December 8, 1888, there is an article on this subject. It begins with the idea that we can tell the pitch of a worm if we have an axial slice section of the worm as at *A*, Fig. 1, and that the term *pitch* should be used in the same sense as it is used in the worm gear *B* that meshes with the worm. The pitch may be the same in the single-threaded worm, Fig. 2, as in the four-threaded worm, Fig. 3, but the *lead* of Fig. 3 is four times as long as Fig. 2.

The boys in the Brown & Sharpe works after lead was adopted are today middle-aged men; they may not even know that any other term was ever used—and so, many years after our old misunderstandings were forgotten, the reading of Mr. Babbitt's article on page 703 comes with a distinct shock. I have re-examined the subject in such books as are available, "Willis' Principles of Mechanism," "Rankine's Machinery and Mill Work," "Prof. Anthony's Essentials of Gearing," and others.

Professor Willis was a genius of his age, and so was Professor Rankine. I have no desire to criticize the choice of terms made by these eminent men, but I feel sure that if they had ever made double-threaded or multiple-threaded screws they would have left us terms that could not be misunderstood, and fewer screws and worms would have been spoiled. Charles Holtzapffel understood, more than sixty years ago, how to use terms in multiple-threaded screws and in long leads that could be understood. In his work on "Turning and Mechanical Manipulation" I find three terms that express the same meaning as *lead.* He was connected with a machine shop and had graduated in what the Philistine editor calls the "University of Hard Knocks." It is needless here to repeat Holtzapffel's terms to express what is meant by *"lead." Lead* is clear and has served; now let us stick to it. I admit that Holtzapffel might have done better to use only one term—by using three he shows that he saw the need of a special term but was not sure which to prefer.

Professor Anthony has made drawings of multiple-threaded worms which machinists have followed. He knows the

value of "lead." If Mr. Babbitt had read Professor Anthony's "Essentials of Gearing," page 63, published ten years ago, Mr. Babbitt might not have written as he did regarding what is taught in the engineering department of Tuft's College. Professor Anthony says: "To avoid misunderstanding, it is customary to speak of the pitch of a thread as the lead." This statement is terse and comprehensive. He does not try to do away with the old term entirely, but modestly asserts that "to avoid misunderstanding, it is customary to speak of the pitch of the thread as the lead."

Now let me say, right here, that it is not expected to have everybody cease to use the term, "pitch of a screw," but I do say that, as the term "lead" to express the advance of a screw thread in one turn has served a good purpose in avoiding mistakes, it should be generally adopted. It is used in a text-book of the International Correspondence Schools, an institution that, no doubt, has as many technical students as a goodly number of other large technical schools put together. It is also used to a considerable extent in Van Nostrand Science Series, No. 116, on "Worm and Spiral Gearing."

Summing Up

The term *lead* is especially useful to express the advance of a screw thread in one turn, when this advance is more than one inch; it is also useful in multiple-threaded screws. From the *lead* can be determined the *turns to one inch* in order to figure the change gears.

For a single-thread screw, if the *turns to one inch* are given, there is not much need of giving the *lead*.

We need the term *pitch* in order to select the proper thread tool. *Pitch* is designated by P and always means the distance between two consecutive threads or between two consecutive teeth. When the *pitch* is measured parallel to the axis of a screw, it may be called *axial pitch*; measured circumferentially, we have the well-known *circular pitch*. If the axes of a pair of spiral gears are at right angles, the axial pitch of one gear is equal to the circular pitch of the other. Measured normally, we have *normal pitch*. One definition of normal pitch is the shortest distance between the centers of two consecutive threads of a worm, or between two teeth of a spiral gear measured on the pitch cylinder. Thus, in Fig. 4, the shortest distance between two teeth $N P$ is the normal pitch.

All these come under the general term *linear pitch*.

With Brown & Sharpe in the "lead," accompanied by a respectable following, it is probable that these distinguishing terms will prevail.

Cadmium is a by-product in the smelting of zinc, and is nearly all obtained in this manner.—*The Brass World.*

Logarithmic Chart for Computing Costs

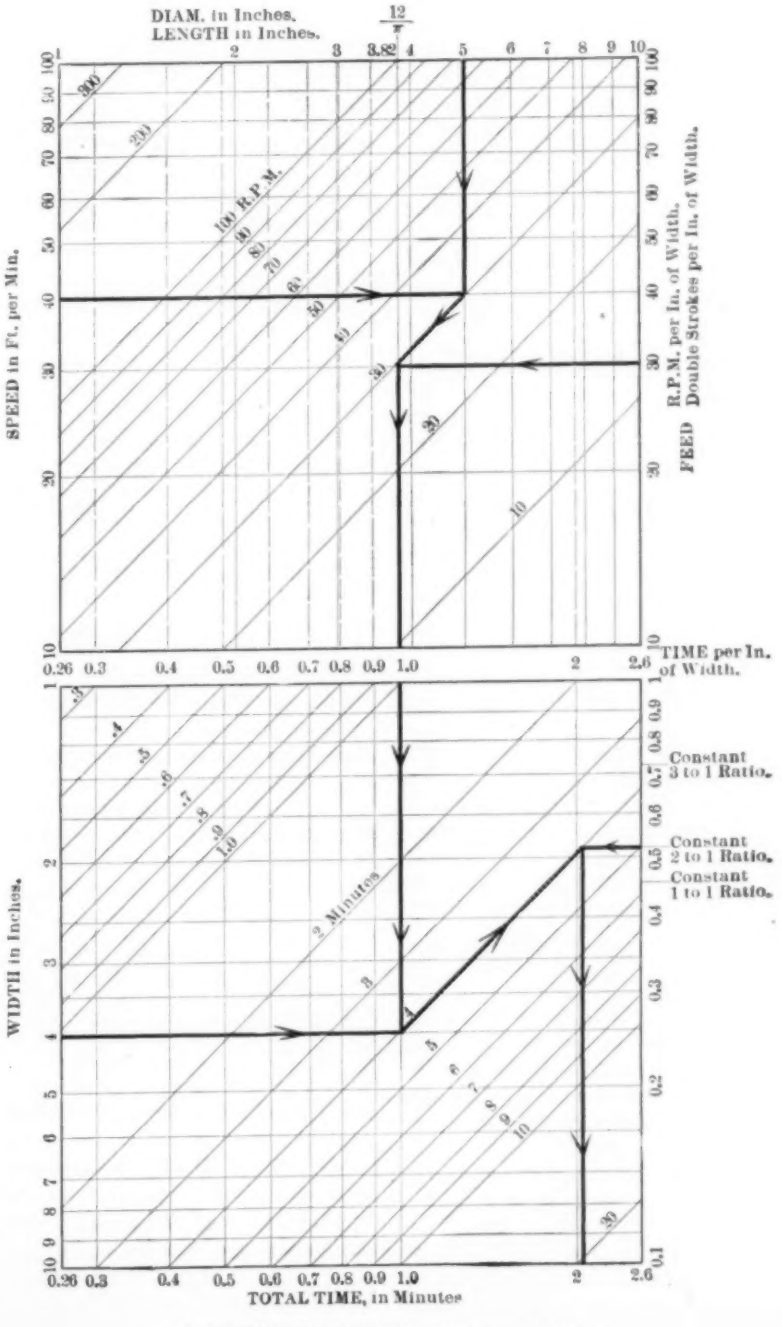
By John Younger

In Vol. 29, Part 2, page 802, of the American Machinist, Mr. Miggett shows a number of slide rules to be used in computing costs and gives a considerable amount of data concerning them. They are of real service, but have an objection in the need of the accompanying constants, with the time lost in hunting them up, even although they may be on the back of the rule. With these compound slide rules one has to remember the previous result when comparing two methods, and figure it mentally. A chart, therefore, embodying Mr. Miggett's idea presented in a graphical form, would get over this difficulty and the constants would be at hand for instant reference.

Such a chart is shown herewith. In general I have used only whole numbers. It would be found desirable to increase the horizontal length so that all the diagonals should meet the top and bottom horizontals. In the lower half of the chart colored inks should be used to avoid confusion between the constants and the total width.

The chart is constructed from the equation:

$$R = \frac{S}{D \frac{\pi}{12}}$$



LOGARITHMIC CHART FOR COMPUTING COSTS

in which R = revolutions per minute, S = cutting speed in feet per minute, and D = the diameter of the work in inches.

From the above equation, we have:

$$S = R\,D\,\frac{\pi}{12},$$

and in logarithmic form:

$$Log.\,S = log.\,R + log.\,D + log.\,\frac{\pi}{12}.$$

If we now assume a definite value for R, that is, a certain number of revolutions per minute, the equation assumes the form of:

$$log.\,S = log.\,D + log.\,C$$

This will be recognized as in the form of the equation of a 45-degree line referred to coördinate axes.

Turning to the upper half of the chart, space off the left-hand vertical for S and the upper horizontal for D, the graduations being logarithmic. This is marked as shown and is easily done by transferring the divisions from a slide rule.

From the equation there will be a 45-degree line across the square for each number of revolutions per minute. These lines can be easily plotted for each number of revolutions by assuming values for either S or D and then solving for the other.

A vertical line marked $\frac{12}{\pi}$ will be noticed, which intersects horizontal and diagonal lines of the same number at the same point. This condition is proved from the equation, for at that point

$$D = \frac{12}{\pi}$$

and

$$log.\,S = log.\,R + log.\,\frac{\pi}{12} + log.\,\frac{12}{\pi}$$

or

$$log.\,S = log.\,R$$

This fact aids in the laying out of the chart.

The chart now reads S, D and R. The lower horizontal and right-hand vertical can be used for another set of conditions in which revolutions per minute are a factor.

Let F = feed in revolutions per minute per inch of width and T = time per inch of width. Then $\frac{F}{R} = T$, or logarithmetically:

$$Log.\,F = log.\,T + log.\,R$$

Assign the left-hand vertical to F and the bottom horizontal to T. The 45-degree lines of course give the relationship of R, and it remains to determine the graduation on T.

For the condition $log.\,F = log.\,R$, $log.\,T$ must $= O$, or T must equal 1. Then the line marked $\frac{12}{\pi}$ is marked 1 on the bottom horizontal, and the line is graduated logarithmetically as shown. This completes the upper half of the chart and expresses graphically the relations between cutting speed, revolutions per minute, diameter or length, feed and time. The heavy blank line shows how the chart should be read for a diameter of 5 inches, a cutting speed of 40 feet per minute and a feed of 30 revolutions per inch of width. The corresponding speed is 30 revolutions per minute and time one minute.

The lower half of the chart brings in the additional features of width, total time and constants. It is constructed in the same manner as the upper. The left-hand vertical is graduated for width in inches, the upper horizontal for time per inch of width taken from the upper half, and the 45-degree lines express total time in minutes, without the use of constants.

The constants shown are calculated for specific cases of shaper and planer work, and in using the chart refer to length in inches and feed in double strokes per inch of width. Speed is the forward or cutting speed of the tool (or may be taken on the diagonal lines as double strokes per minute), and a ratio takes into account the return stroke. The total time read on the bottom horizontal is derived from the total time as expressed by the diagonal lines and the constants.

Following the heavy lines, we assume a shaper job 5 inches long, 4 inches wide, cutting speed 40 feet per minute, feed factor 30 revolutions per inch of width, and a return ratio of the ram of 2:1. The total time to machine we find to be a little over 2 minutes. The numbers on the chart may be multiplied or divided by powers of 10, provided the other variables are changed accordingly.

The total time thus derived has only to be multiplied on the slide rule by the rate of the operator, the shop expense added, and the total cost of the operation is found. The principal of this logarithmic chart is applicable to many calculations, such as horse-power, weights, costs of material, and others; any calculation, in fact, which takes the form of $A\,B = C$ which can be written into the logarithmic equation $log.\,A + log.\,B = log.\,C$ and in which A, B and C are variables.

Tests of a pneumatic hammer, states the *Industrial World*, reveal the fact that a very slight error of design or adjustment of the valve may affect the efficiency of the tool to a very marked degree. With a certain hammer, giving 936 blows per minute, the piston had a velocity of impact of 38.56 ft. per second at the end of the forward stroke. A slight improvement in the valve increased the number of blows to 1040 per minute, while the velocity of impact at the end of the forward stroke was 44.65 feet per second, resulting, of course, in a much more effective blow.

Danger of Aluminum in Composition Scrap

The rapidly increasing use of aluminum in yellow brass has been instrumental in bringing about a peculiar condition in the scrap metal business. Brass founders purchase scrap composition from dealers and when melted and cast it is found that it contains aluminum and the castings are injured. This is particularly true of castings that are to stand pressure.

The dealer sells the metal to the brass founder in good faith and he is wholly ignorant of the fact that it may contain aluminum. He has sorted it out to the best of his ability and knowledge, but in spite of this care, aluminum has crept in.

The reason for this condition is the fact that large quantities of manganese-bronze (which contains aluminum) or yellow brass containing aluminum, are now sold. The castings sooner or later find their way into the scrap metal market.

One would naturally think that it would be an easy matter for the scrap metal dealer to distinguish between manganese-bronze and composition, as it is a simple matter to do so with freshly made castings. The surface then tells the story. In the case of scrap, however, it is not easy to ascertain whether a casting is one or the other. The surface is usually so dirty and discolored that it offers no clue to the mixture. If the metal be filed, manganese-bronze shows an orange color like that of ordinary composition. The trained eye of the expert will usually be able to distinguish it, but the labor employed in the scrap metal establishments cannot do so.

The presence of aluminum alloys in composition scrap is already causing considerable difficulty in the metal trade, and it will undoubtedly grow worse instead of better on account of the increase in the quantity of aluminum and aluminum alloys that is being manufactured.—*The Brass World.*

France has a present problem in the wine growers' agitation in the south, and future difficulties in the increasing cost of gasolene. Marquis de Dion, vice-president of the A.C.F., believes that the automobile can again save France as it saved it a few years ago. In the chamber of deputies recently he declared that there are 40,000 automobiles in France consuming about 33,000,000 of gasolene per year. If, instead of using gasolene, these 40,000 cars employed home-produced alcohol, the north would no longer be obliged to produce sugar to adulterate the wines of the south, honest wine growers would be free from competing adulterators, and the automobile would have an unlimited supply of fuel. The marquis has asked for an extraparliamentary commission to consider the matter.—*The Automobile.*

An Interesting Molding-machine Job

Showing How Nine Different Castings Can Be Produced from One Machine, by Making a Few Alterations in Its Set-up

BY ROBERT PATTEN

The piece here illustrated and described is a beam head for a cotton loom; it was mounted on a Pridmore molding machine. The method used in mounting the pattern was such that, by making a few changes, it was possible to produce nine different beam heads from the one machine.

The Casting To Be Made

As everyone is not familiar with textile machinery it may be of interest to explain that these castings are used one on each end of a warp beam in a cotton loom; the warp beam is a wooden roll about 5 inches in diameter, and of the length of the loom; these heads are bolted to each end and then on the beam is firmly wound the warp to the full diameter of the heads, thus the name beam head. These beams are placed in the loom, and when empty they are replaced by full ones. Some looms require 16-inch ones, and others 17-inch or 18-inch. Some mills prefer the gear and friction, some gears only, and some use friction only, according to the class of goods to be woven. This gear or friction lets off the warp as fast as the loom weaves it, and it is rewound on the take-up.

At Fig. 1 is shown the beam head, as made with gear and friction ring, either 16 inches, 17 inches, or 18 inches diameter, all other dimensions being as shown in sketch. The parting lines of the mold are shown at P and P_1, P_2 being the parting of the friction ring.

Fig. 2 is a vertical section showing the pattern mounted on the machine; at the right-hand side of the center it is shown as mounted for making a beam head with gear only, and made in a two-part flask; at the left-hand side of the center it is shown as mounted with gear and friction and made in a three-part flask.

The Pattern for the Nowel Stripping Plate

In fitting up the nowel for this job, the wooden pattern of the nowel stripping plate is made enough larger in diameter than the beam head to allow plenty of room for sand in the flask around the edge of the head. This plate has ears on the opposite sides for dowel pins, to match the ears on the flask. Finish is allowed on top of the plate, and on the bottom at the edge where fitted to the frame of the machine. The center of this stripping plate is cut away, leaving a finish at the circle at the root of the tooth of the gear, as shown in section at Fig. 4. The pattern is made so that one-half the thickness of the beam head is made on this plate, as at A, Fig. 4.

The Gear Pattern

Next a master gear blank is turned out with a heavy flange on the inside at the bottom, as shown at F, Fig. 2. The arms in this blank are formed by a cross of four arms with a hub heavy enough to use in turning the iron pattern and strong enough to be rigid while the gear is being cut; the arms and hub are cut out after the gear is finished.

The Pattern for the Friction Ring

The pattern of the friction ring F, Fig. 2, is made with finish allowed all over, and

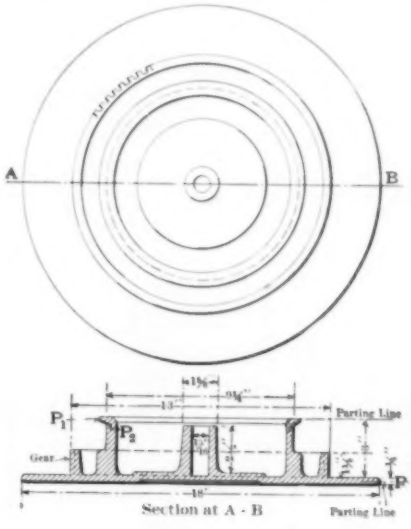


FIG. 1. THE "BEAM HEAD" CASTING

is long enough to reach through the stripping plate and be bolted to the pattern support X.

The Pattern Support

Fig. 5 is a sketch of this pattern support; it is a ring, the outside diameter of which is the same as that of the operating frame of the molding machine. It has arms strong enough to be rigid when the gear, friction and center hub (H, Fig. 2) of the beam head are bolted to it, as these three parts are stripped through the stripping plate by the operating of the machine.

The Stool Support

Fig. 6 is the stool support (X_1, Fig. 2) with the studs S, Fig. 2, cast to the flange; this support is bolted to the bottom of the molding machine. Two of these supports are necessary, as the head with the gear and friction requires two circles of studs, the outside circle to support the stripping ring S, Fig. 2, and the inside circle to support the ring S_2, Fig. 2.

The cope stripping plate is made from the same pattern as the nowel stripping plate by having the center filled in.

The Process of Fitting Up the Machine to Make the Nowel

In fitting up the nowel on the machine the gear is first finished to size and cut. A portion T, Fig. 2, of the under side of the teeth, is cut away in the pattern to save time in cutting the gear, the face of this gear being enough to reach through the stripping plate to its bearing on the pattern support. The arms are then cut out of the gear, as previously referred to, the flange on the inside at the bottom making it strong enough so that it does not spring out of true.

Finishing the Stripping Plate

The nowel stripping plate is next turned to the right thickness; half of the thickness of the pattern is turned on this plate as at A, Fig. 4; also the grooves to receive the different sizes of rings as shown by 16-inch, 17-inch and 18-inch diameters, Fig. 4, are turned out about $\frac{1}{8}$ inch deep, the outside diameter of this groove being the exact diameter of the 18-inch head, and the inside diameter being small enough to allow the 16-inch ring to be rounded over as at B, Fig. 4. The edges of the 17-inch and 18-inch diameter flanges would come as shown by the dotted lines.

The inside of this stripping plate is turned out the exact size of gear at the root of the tooth, as shown in Fig. 4. The top of this plate is then given a coat of sulphate of copper, and the gear is placed on top of it, so that the inside diameter of stripping plate matches the diameter at roots of teeth of the gear, and the outline of the teeth is scribed accurately on the plate; after removing the gear the tooth spaces are worked out, by first drilling a hole as near as possible to the size of the point of tooth and then hack-sawing out the pieces, as indicated at C, Fig. 4. The stripping plate is then filed nicely to the scribed line until the gear will go through freely. This plate is now ready to drill for dowel pins.

The Cope Pattern Plate

The cope plate, Fig. 3, is turned on the top side, the groove for 16-inch, 17-inch and 18-inch rings being turned exact size, as in the case of the nowel plate; the

other half of the thickness of the pattern is turned on this plate the same as on the nowel plate.

Drilling the Plates for the Dowel-pin Holes

They are now both ready to be drilled for dowel pins. To locate these two plates exactly, a ring is laid in the groove of the cope plate with a slight blocking underneath, as at *B*, Fig. 7, which raises the ring so that when the nowel plate is placed above it, the ring projects into the groove of each plate, making each plate true with the other. A jig which had been laid off and drilled, and provided with bushings fitted to the holes, is then clamped to these plates, and both are drilled at the same time; the usual dowel pins and bushings are then fitted, one of each in opposite ends.

Fitting Parts to the Machine

The nowel plate, and the pattern support, Fig. 5, are then drilled with the jig which goes with the molding machine. The pattern support *X*, Fig. 2, is then fastened to the operating frame of the machine, and the nowel stripping plate is

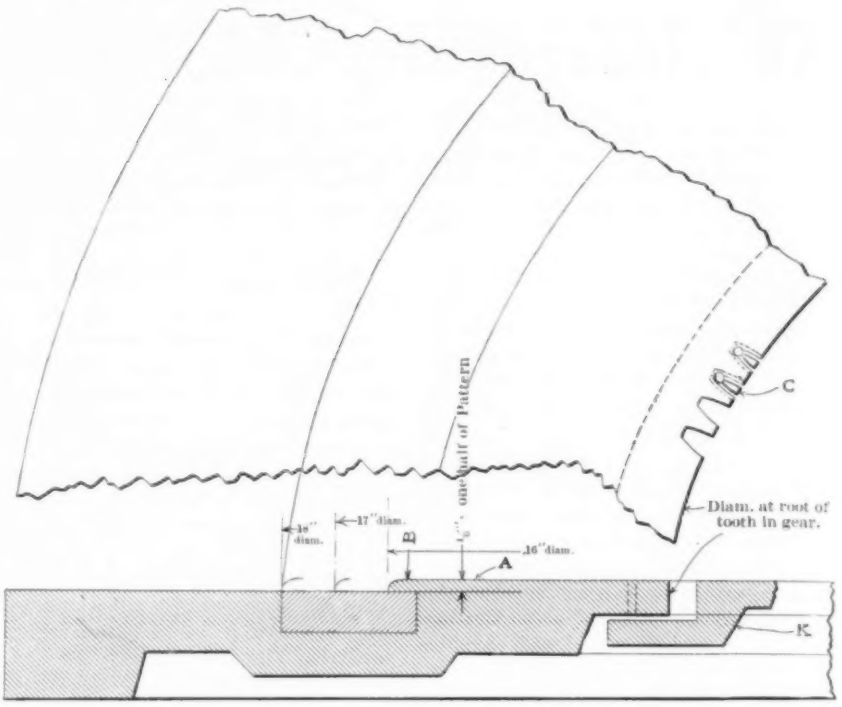


FIG. 4. SECTION OF STRIPPING PLATE, SHOWING INTERCHANGEABLE RINGS FOR MAKING 16-IN., 17-IN. AND 18-IN. DIAMETER HEADS

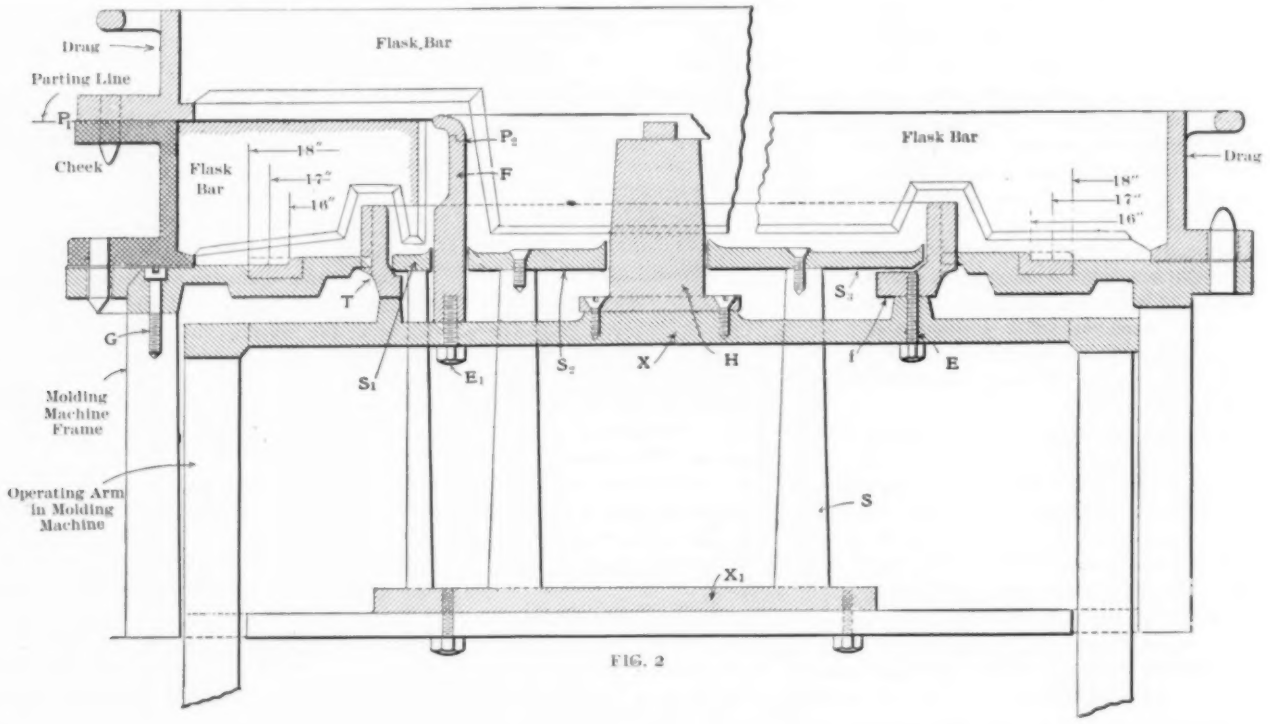


FIG. 2

This side showing the beam head with gear and friction as made in a 3-parted flask, making either 16in. 17in. or 18in. diameters.

This side showing the beam head with gear only as made in a 2-parted flask, either 16in., 17in., or 18in. diameters.

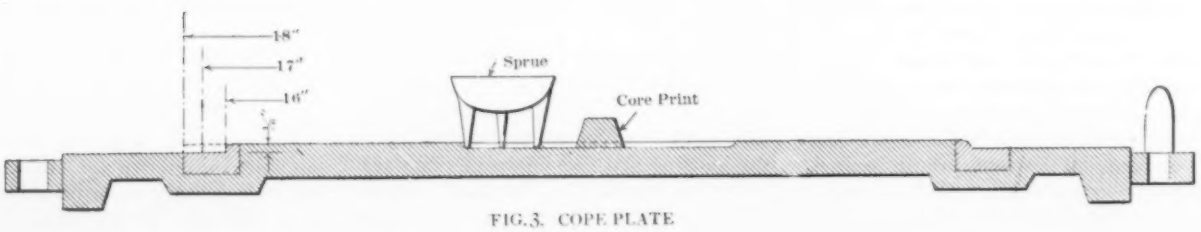


FIG. 3. COPE PLATE

placed in position on the machine, and screwed as at G, Fig. 2; the gear is then dropped into position through the stripping plate, on to its bearings on the pattern support, and is clamped firmly to the support. It is then, along with the support, removed, drilled, screwed and doweled to the support, as at E, Fig. 2.

The Pattern for the Friction Ring

The friction ring F, Fig. 2, which is then turned, is made in two parts with parting, as shown at P_2, Fig. 2, this parting being a loose fit so that when the drag flask is lifted off the mold this ring will lift with it.

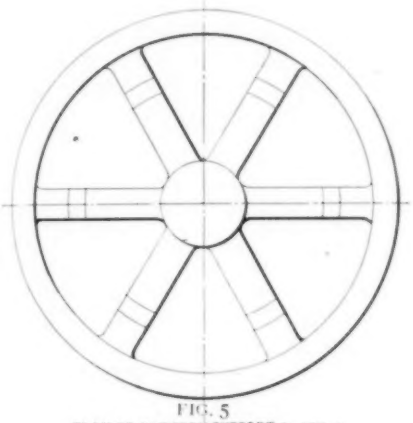


FIG. 5
PLAN OF PATTERN SUPPORT X, FIG. 2

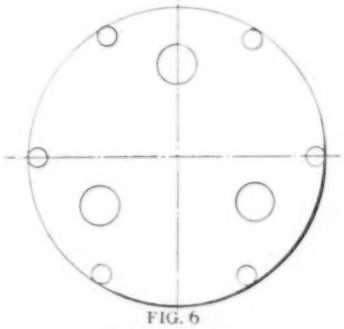


FIG. 6
STOOL SUPPORT X_1, FIG. 2

Fitting and Assembling the Stripping Rings, Etc.

The stool support is now fitted to the bottom frame of the molding machine, the pattern support with the gear on it is placed in position again, and the friction ring is set in position. The stripping ring is turned to thickness with a hole turned in the center the same diameter as the hub H, Fig. 2. The outside diameter of the ring is a working fit for the inside diameter of the gear; this ring is then cut in two, making the rings S_1 and S_2, the inside diameter of S_1 being the same as the outside diameter of the friction ring and the outside diameter of S_2, the same as the inside diameter of the friction ring. The ring S_1 is then placed in position, and this will locate the friction ring in place for clamping and bolting to the pattern support, as E_1, Fig. 2. These stripping rings, S_1 and S_2, are screwed to the stool support by flat-head machine screws.

The hub H, Fig. 2, is turned to size and placed in position, and screwed to the pattern support, as shown.

The pattern is now mounted for the three-parted beam head; in order to make the different diameters—16-inch, 17-inch or 18-inch heads—there are made, for both cope and nowel, interchangeable rings which fit into the grooves at B, Fig. 7.

Making the Nowel Mold

To make a mold of this nowel the cheek flask is placed in position, with bars, as shown in Fig. 2; the flange ring is placed on the friction ring, as at P_2, with a heavy cover weight placed on it to keep it down firmly while tucking sand, also to keep sand out from the center of the friction ring. The cheek flask is rammed up in the usual manner, and struck off as at the shaded lines at parting P_1; the weight is then removed from the ring, the drag flask placed in position with bars, as shown, made in the usual manner, struck off, and the bottom board rubbed on. The machine is now operated, drawing down the gear, and the friction ring from P_2, and the hub; the drag is now lifted off and turned over, the flanged ring of the friction is lifted off the drag, and the cheek is removed and placed on the drag.

The Cope

The cope plate being only a flat plate, no machine is used. This plate is, by changing of the different diameter rings, used for nine different heads, the mold from the cope being made in the usual manner. It is poured by a three-legged cup-shaped sprue, as shown in Fig. 3, this sprue being reamed up in the cope and removed before the cope flask is lifted off.

Making a Head with Gear Only

To make the two-parted head with gear only, the friction ring F, and stool support X_1, Fig. 2, are removed, another stool support, having a stripping ring as shown at S_3 on the right-hand side of Fig. 2, is placed in position, which makes it ready for the barred two-part flask shown.

Making a Head with Friction Ring Only

To make the beam head with friction only, the gear is removed from the pattern support, and the ring S_1 is changed for a larger ring to take up the space left by the gear. This ring is lipped at the outside edge, as shown at K, Fig. 4, to allow of babbitting around the stripping plate, where the gear is stripped through.

Thus, by a few extra small pieces, the nine different beam heads are produced from the one machine.

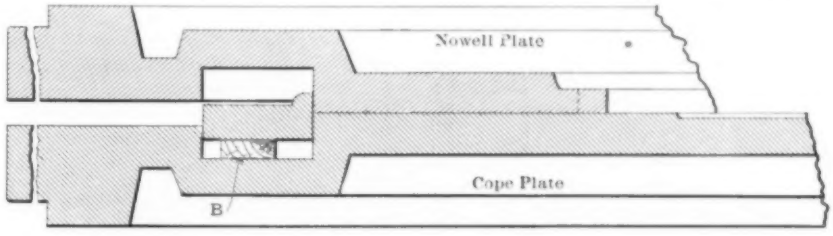


FIG. 7. SHOWING COPE AND NOWEL PLATES PUT TOGETHER AND CENTERED BY RING, FOR DRILLING DOWEL-PIN HOLES

Internal Grinding and Lubrication

By H. N. Jackson

In internal grinding, where water is used, the material that is removed is washed out but it is believed that the wheel picks up particles of dirt and grit from the water to sort of glaze it over and affect the freedom of cutting.

It is possible that if the wheel always cut at the top of the hole, out of the way of the water and dirt, there would be less of this condition.

While the writer has made no experiments regarding the relative advantages of plain or soda water for this purpose I do not think there would be much of any difference.

I understand that the Norton Grinding Company has gone into this matter very thoroughly and found it no disadvantage whatever to use soda or even oil and soda in the water used in grinding. This was of course on external grinding where a heavy wheel is mounted between massive bearings and on a heavy frame so that the wheel can be held rigidly to the work. With internal grinding the conditions are very different.

Gasolene Not So Dangerous

At the recent meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, E. W. Roberts performed some startling experiments with gasolene, lighting the vapor as it arose from an ordinary can and pouring gasolene into it as it burned, showing that it could not flash back into the can, as that was full of gasolene vapor forming rapidly enough to expel the air and burning only after it issued into the atmosphere. The only danger of explosion is when a very small quantity of gasolene evaporates in a vessel, forming not enough vapor to expel the air, but sufficient to make with it an explosive mixture.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

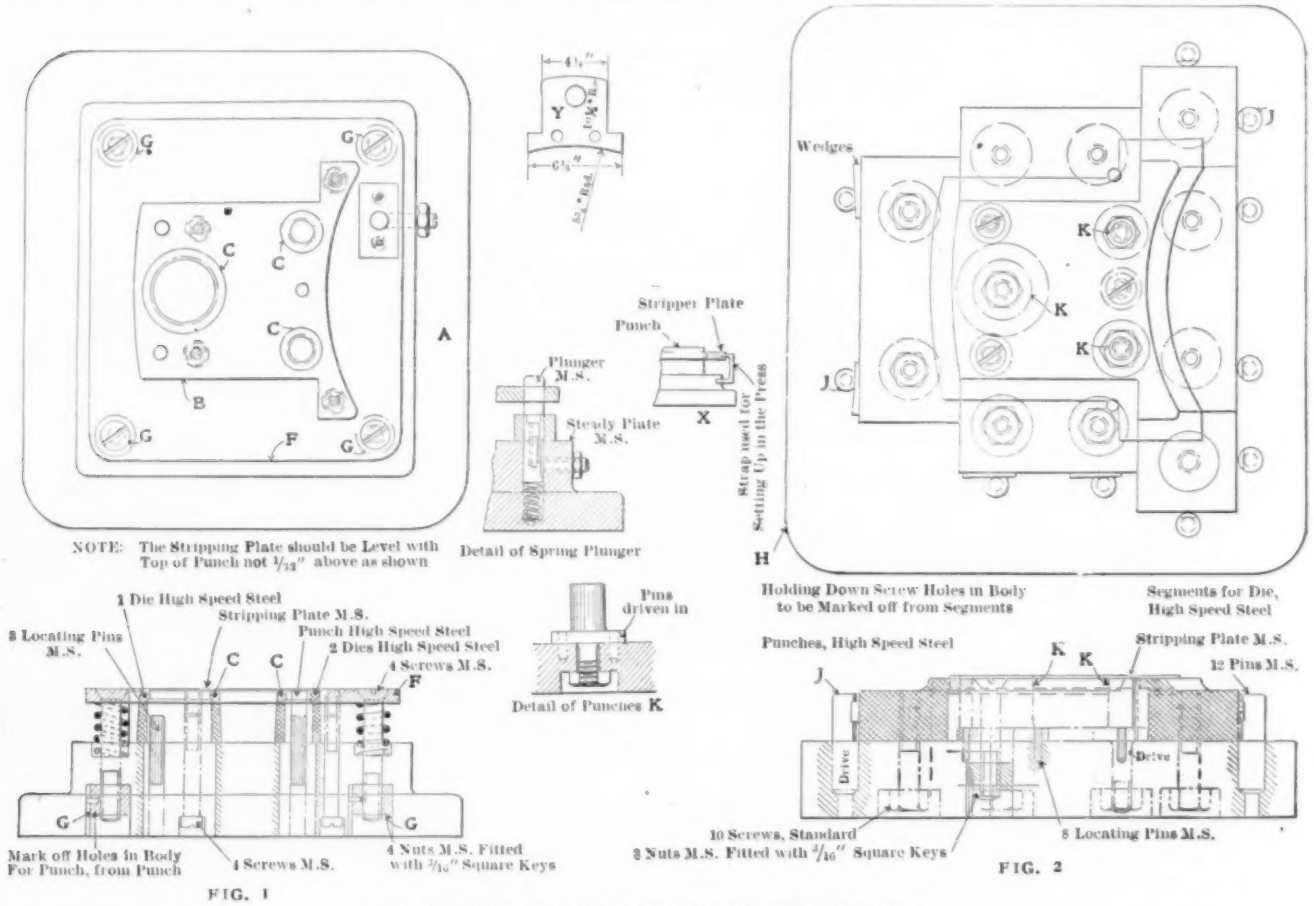
WE PAY FOR USEFUL IDEAS

Compound Punch and Die for Pole Piece Laminations

The accompanying sketches show a compound punch and die for producing plates for laminated pole pieces, as shown at *Y*, complete at one stroke of the press. These tools were designed after a careful study of existing tools for the purpose—that is, tools in actual use and those illustrated in the AMERICAN MACHINIST, etc. The first set has now been in use over two years and I have not found it necessary to depart from the original when designing other sets that have since been made. Although the results arrived at are the same, opinions differ as to the way these tools should be built up. In the first place, the design selected depends somewhat upon the type of press the tools are to be used upon; the tools that are the subject of this article are for use on a plain press not equipped with knockout arrangements.

A point that sometimes dominates the type of tool selected and the way of building it is the number of punchings likely to be required from the tool. Sometimes orders are received for two or three machines with laminated poles, and if the standard laminations cannot be used, a set of tools must be made, as cheaply and quickly as possible, that will hold up long enough to produce the number of punchings required. In a special job of this sort a saving can at times be effected by splitting up the operations instead of making tools to produce the blank at one blow, that is, by taking parts of existing tools away and using only the part that will suit. In this way the job can at times be accomplished by making only a small part of a tool, the cost of extra operations and time occupied in rigging up the tools often is less than what a set of new tools would cost, and which would perhaps never be used again. Although I do not believe in splitting up the operations for standard work as practiced in some shops—with a view to economy—owing to the greater chance there is of inaccuracy, and to the fact that one or more of the presses is tied up for a considerable time on the one job, nevertheless, we are at times compelled to do this owing to the quick delivery required, which does not allow us sufficient time to make new tools.

When designing these tools the points aimed at were to obtain the best results in the quickest time with the least expenditure of money and labor, to reduce the amount of accurate machinery and fitting as much as possible so that men of ordinary intelligence could make them. Fig. 1 shows plan and elevation of punch and die. *A* is a cast-iron plate machined top and bottom. *B*, the punch for the blank, is made of tool steel but is not hardened. After marking out it is machined top and bottom to the required thickness and then strapped to the face plate in the lathe and the three taper holes for the dies bored accurately to size and in the correct position. The top face of the punch is recessed about ½ inch deep to within ½ inch of the outside edge all round. This enables the punch to be more readily peened to size again when it has become



COMPOUND PUNCH AND DIE FOR LAMINATED POLE PIECES

worn. The dies *C* are made of tool steel and are hardened, and ground on the taper portion and also on the cutting part of the hole, which is slightly enlarged below to enable the punchings to fall clear. After driving into the taper holes in the punch the outside cutting edges of the punch are carefully worked up to size and the bottom face ground perfectly flat. It is now located and held firmly in position on the plate by screws and pins shown. This method of holding the dies in the punch answers very well, for in operation the tendency is to force them more firmly in position. The stripper plate *F* is made of wrought iron and is machined on the top face only. It is adjusted and held by the four screws and nuts *G*, which slide in holes drilled underneath the plate and are prevented from turning round when the screw is being adjusted by a small pin driven into the nut, the end of the pin fitting into a groove cut in the hole. I think this adjustment much better than the ordinary fillister-head screw inserted from underneath, as generally used, and which requires alteration every time the tools are ground, and cannot be adjusted when the tools are in the press; besides, the straps sometimes used for setting purposes, as shown at *X*, are done away with. When setting the tools in the press the stripper plates can be readily screwed down a little way below the cutting edges, allowing the punches to enter the dies, and after the tools are firmly clamped to the machine the strippers can be rapidly adjusted to the proper position again. Guide pins are very useful for setting purposes, but cannot be used on this job, owing to being in the way of the sheet being punched.

In the compound die the plate *H*, Fig. 2, is made of cast iron, and is machined top and bottom. The die is built up of tool-steel segments, which are hardened, and ground on the underneath faces, cutting edges and ends. These segments are firmly held down by hexagon-headed screws inserted from underneath, and all are firmly held together and adjusted by the wedges knocked in between the segments and the pins *J*—which are driven into the plate. This method of wedging up the segments is very cheap, and is all that is required. In my opinion it is unnecessary to have special patterns made, and accurate locating grooves machined in the plate in which to locate the segments, or to have a web cast round the edges, the segments being held together and adjusted by screws in the web, the arrangement shown does away with accurate machining of the plate. It is best whenever possible to so arrange the segments that all the cutting edges can be ground after hardening so that any alteration of the shape can be rectified. The segments of the die shown can all be ground, with the exception of the two small corner tip segments, but in this case they are the ones most unlikely to cause trouble in hardening. The punches *K* are also a departure from the usual style used on this class of tool. Instead of being driven into the plate, they are a loose fit, the idea being to do away with as much accurate machining and fitting as possible. When fitting the tool together the punches—owing to their being a loose fit in the plate—can easily be moved a little and made to enter the dies, and when they are accurately located in position, the nut on the threaded end of the punch is tightened up and holes are drilled—through the existing ones drilled in the collar—in the plate into which pins are driven, thus holding the punch firmly and accurately in position. The stripper is machined and adjusted in the same way as on the punch. A spring plunger is provided on the punch to guide the sheet; it is located about 3/32 inch from the cutting edge. The idea will be clear from the detail sketch without further description. For stripping purposes I find it best to use rubber, although springs are shown in the sketch. A considerable amount of power is necessary, and a number of good strong springs would be required. In operation the punch is on the bed of the press so as to allow the punchings from the holes to fall through the hole in the press body.

JOHN CHERRY.

A Pump Experience in the West

On page 892 I noticed an article which was quite interesting to me, entitled "A Pump Experience in the West" and signed Senex Occidentalis. The article is interesting to me from the fact that while he wants a good deal of information, he does not give very much himself. However, from the facts given he is perfectly correct in blaming the check valve for the trouble, and no practical engineer would put a check valve on the discharge of a single-acting pump with so great a rise. It would, as he says, make the air chamber entirely useless to cushion on, and every stroke would be a hammer. If it was running at the speed necessary to discharge a volume of water for an eight-inch pipe, I do not wonder much that he did not want to stay in the mine with it.

I would say to the Old Man of the West, next time give us a few more details. What was the size of the suction, and how much was the lift? Was there a vacuum chamber on the lift or not? Again, what was the size of the suction valves and also of the discharge? What was the size of water piston? How many strokes a minute and what length of stroke? How many gallons of water discharge per minute? While the check valve was certainly enough to cause the trouble, there might have been other wrong features.

F. A. TAYLOR.

Brazing Cast Iron

Since my article on a brazing flux for cast iron, printed on page 609, Vol. 30, Part 1, appeared, I have had a number of letters from interested parties seeking additional information. Some of the letters indicate almost a total lack of knowledge of ordinary brazing methods. Let me say right here: If you cannot do common brazing do not attempt to learn on cast iron. To those who wish to learn something about ordinary brazing I would refer to J. H. Bain's article, on page 775.

Several of my inquirers had trouble on very thin castings, and it is a difficult thing to braze anything that is of such shape as to warp when heated, but with a little care many things can be mended which at first look impossible.

The most important thing in brazing cast iron is to be sure and have heat enough and to heat the piece evenly where the heat is needed. Do not apply flux, whether mine or any other kind, to cast iron till the piece is almost or quite at the brazing heat. If you do you will have trouble in many cases. Do not imagine that because you were successful in a trial where you did not follow directions, that you will be every time, for you will fail on some job that will make you wish you had done differently. Cast iron is treacherous and experience on thousands of pieces of all shapes and sizes taught me the imprudence of applying flux to cast iron before a good cherry heat is attained.

Another good flux that can be used where a quick flow is more desirable than strength is as follows: Boric acid 1 pound, caustic soda 3 ounces, carbonate of iron 3 ounces. This flux flows nicely on cast iron, but my own experience has been that it does not form as strong a union of the broken parts as the one given in my former article.

Both mixtures should be mixed with good yellow grain spelter and applied as directed. Both must be kept dry—preferably in a tight glass jar or bottle—only a little taken out when wanted. In trying these mixtures experiment on a fair-sized piece of cast iron, say one inch in cross section, before attempting very thin pieces, in order to learn the action of the flux.

For brazing wrought iron, steel or malleable iron I have found the following mixture the best I have ever tried: Boiling water, one part; common borax, one part. To the solution add two parts of boric acid. This makes a thick, creamy mass, and does away with the necessity of using fused borax. In using this flux the pieces are painted with it before putting them into the fire. When the brass is put on it will flow wherever the flux has been applied. No attempt should be made to use this last flux on cast iron as it is not suitable.

ETHAN VIALL.

Elliptical Gears

Being much interested in M. B. F.'s article on elliptical wheels, at page 479, Vol. 30, Part 1, it might be acceptable to your readers to have my experience with this class of gearing, which is applicable where the wheels have to work not on their foci, but on their centers; and it might be added that, although as M. B. F. says, very little has been written on the former subject, still less has appeared on the latter, which is the one that has mostly come my way; and as there are certain peculiarities relating to this class of gearing, these remarks may come in useful to anyone designing a pair for the first time.

The Conditions under Which the Gears Were Used

The conditions to be fulfilled are as shown in Fig. 1. Shaft *a* being the driver, shaft *b* is to be rotated at four distinct

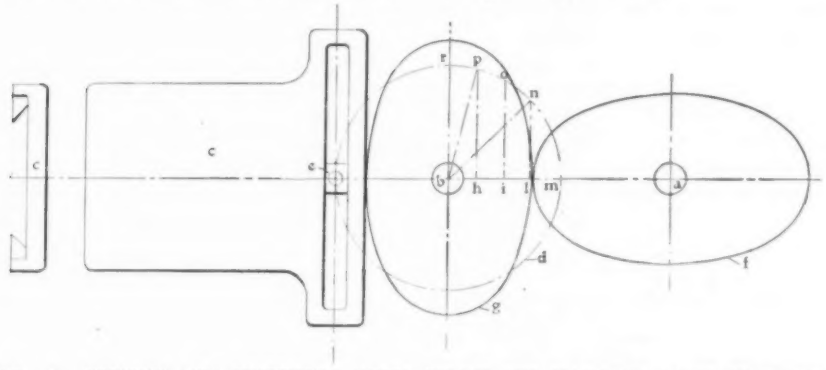


FIG. 1. SHOWING THE CONDITIONS UNDER WHICH THE ELLIPTICAL GEARS WERE USED

variable speeds, so that the reciprocating motion transmitted to slide *c* from the crank disk keyed to shaft *b* and its crank pin *e*, revolving in the path *d*, working in the slot in slide *c*, shall be as nearly constant as possible, the elliptical wheels *f g* being introduced as an equalizing motion. In some cases a connecting rod is used to couple the crank pin *e* to the slide *c*.

This style of drive is used in slot-drilling machines of the horizontal, vertical and portable types; circular slot-milling machines, where a reciprocating rack oscillates the work table backward and forward; and grinding machines for plain holes, radial links, etc., where an up-and-down motion is given to the spindle; and as my firm makes several sizes of each type of these machines, it will be seen that considerable numbers of elliptical wheels are required.

Standard Wheels

With a view to having the different sizes of these wheels as few as possible, so as to minimize the cost of templets and tools for same, the accompanying list was fixed upon some years ago:

In each wheel the major and minor axes are proportioned to give approximately the nearest result to a constant speed at the point of reciprocation.

An Example Worked Out

To give an example, let it be assumed that the slide moves through equal dis-

No. of teeth	Pitch
34	⅜ inch
38	½ inch
42	⅝ inch
46	¾ inch
50	⅞ inch
54	1 inch

tances in correspondingly equal times, as shown in Fig. 1, at *h, i, l, m*, then the positions of the crank pin at these same times will be at *p, o, n, m*.

Now the square root of the ratio of the angle *n b m* to the angle *r b p* gives the approximate ratio of the major to the minor axis of the required ellipse.

In the example given this is worked out as follows:

$$\sqrt{\frac{angle\ n\ b\ m}{angle\ r\ b\ p}} = \sqrt{\frac{40^\circ}{15^\circ}} = \sqrt{2.66} = 1.6;$$

Then, where A and B are respectively one half of the major and minor axis, see Fig. 2,

$$A : B :: 1.6 : 1 \text{ or } 8 : 5. \qquad (1)$$

And, since the periphery of an ellipse (P) equals

$$2\pi\sqrt{\frac{A_1 + B^2}{2}}$$

then to find A and B when P is given

From (1) we have $B = \frac{5}{8} A$

$$\therefore P = 2\pi \sqrt{\frac{A^2 + (\frac{5}{8} A)^2}{2}},$$

$$= 2\pi A \sqrt{\frac{1 + \frac{25}{64}}{2}},$$

$$= \frac{2\pi A}{8} \sqrt{\frac{89}{2}},$$

$$= \frac{11}{14} A \sqrt{44.5},$$

$$= 5.24\, A.$$

Taking the second wheel in the list, 38 teeth, ½-inch pitch, then in this case $P = 38 \times \frac{1}{2}$ inch $= 19$ inches; $\therefore 19 = 5.24\, A$; and $A = 3.625$ in., and the major axis $= 2A = 7\frac{1}{4}$ inches or 7.25 inches; also $B = \frac{5}{8}\ A = 2.2656$ inches, and the minor axis $= 2\ B = 4\ 17/32$ inches, or 4.5312 inches.

Gears Turning on Their Centers Cannot be True Ellipses

Having fixed these main considerations it may be remarked that though two equal ellipses will roll together on their foci such is not the case when working on their centers. Referring to Fig. 2 it will be seen that the two ellipses leave one another between the points *s* and *t* and it is necessary to broaden the ends of the ellipse between these points as shown in dotted lines. This gives a false ellipse or oval as the correct form for this type of wheel, and the slight difference in the periphery (length of pitch line) of this

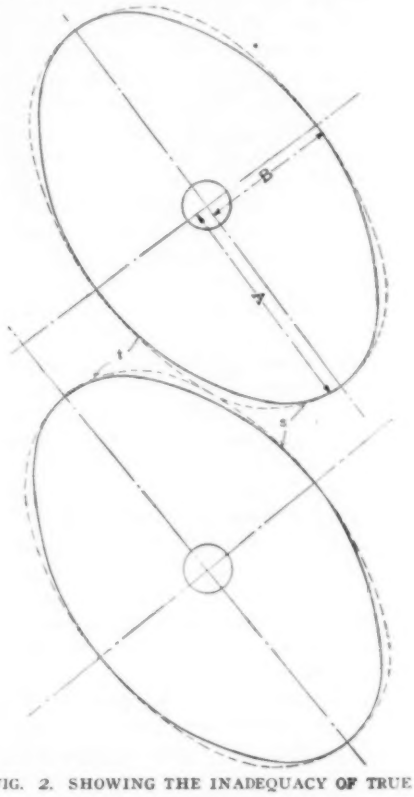


FIG. 2. SHOWING THE INADEQUACY OF TRUE ELLIPSES REVOLVING UPON THEIR CENTERS

oval shape and the previously calculated true ellipse can be neglected.

The Dimensions Arrived at

For the example given radii are now obtained as shown in Fig. 3 at *v* and *v'* to approximate to this oval shape and in this case these work out respectively at 5 $\frac{11}{12}$ inches radius suitable for 75 teeth, and 1⅞ inches radius suitable for 24 teeth.

Note—If a straight line *w x* be drawn through the centers of these radii it will be found to cut the ellipse at the point where the two circular arcs touch one another, so that the line *w x* is normal to both arcs.

After adding an amount allowable for the top of the teeth, a templet or former plate is made of the same size for a purpose hereinafter described. The same calculation is gone through and a templet made for each wheel in the list.

NUMBER OF TEETH WHEN REVOLVING ON A FOCUS

It may be mentioned here that in M. B. F.'s case the wheels may have either an even or odd number of teeth whether they are cut singly or a number together, but an odd number is preferable (29 in his case) as it gives the major axis passing through the center line of a tooth and a space respectively. With an even number of teeth the major axis would pass through the edge of a tooth at either end and this is not so handy for setting purposes.

NUMBER OF TEETH WHEN REVOLVING ON THE CENTER

Now in elliptical wheels working on their centers there must be an even number of teeth whether they are cut singly or a number together, but it is preferable to make the number so that, where N equals the number of teeth, $\frac{N-2}{4}$ will be a whole number, thus, if $N=38$, $\frac{N-2}{4} = \frac{38-2}{4} = 9$, a whole number. This gives the major axis passing through the center line of a tooth at either end and the minor axis through the center line of a space at either end, as shown in Fig. 3.

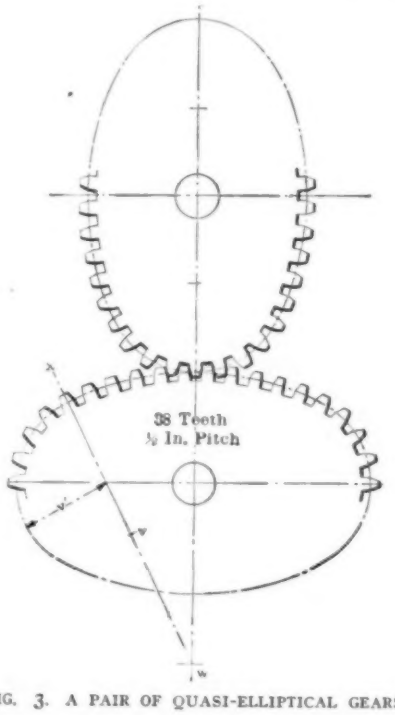


FIG. 3. A PAIR OF QUASI-ELLIPTICAL GEARS

The foregoing points must be noted more particularly in case of making a pattern, for, if neglected, when casting two wheels to work together from one pattern they would not gear up with their axes in line.

THE PROCESS OF CONSTRUCTION

As these wheels in my case are generally made of cast iron each blank is cast separately. They are first bored, the bosses turned and faced and the sides of the wheels also faced. The periphery is then milled on a vertical profile milling machine, the former plate previously mentioned being required for this purpose.

CUTTING THE TEETH

For cutting the teeth, exactly the same method as advocated by M. F. B. is adopted and is found to be quite good enough for all practical purposes. The wheels are now key-wayed and are then ready for putting in their places.

THE THEORETICALLY CORRECT METHODS UNNECESSARY

I have intentionally refrained from giving the theoretically correct method for setting out the teeth of these wheels, where each tooth has to be set out on a separate center line, obtained by drawing lines from the center of each tooth through each of the foci, and bisecting the angle contained by these lines, the bisecting line being the required center line. The expense entailed by this method is out of all proportion to the slightly improved form of tooth obtained.

S. M. LOWTHIAN.

Arithmetical Short-cuts

There are many short cuts but as far as general arithmetic is concerned for all practical uses I have yet to find anything to beat logarithms.

Take example 1.

$7\,789$	= log.	0 89148
0.7854 =		1.89509
		0 78657

= 6.117, nearly.—Ans

Where the example includes division it is probably a little easier to use the cologarithm and add same.

Percentage is only useful where one of the amounts is an even percentage; i.e. to multiply by 75 is equal to ¾ of 100; 90 is equal to 100 — 10 per cent.; 66⅔ is equal to ⅔ of 100; 475 is equal to 500 less 5 per cent. The main practical use of any short method is for checking purposes. I have yet to meet the expert who used them. They all read nice and look easy on paper but it is hard enough for the average individual to remember the general rules without bothering about short cuts.

Short cuts are like a lot of catch questions. I will give one. What is the sum of the cubes of the natural numbers from 1 to 100? Ans. The sum of the cubes is equal to the square of the sum—i.e. 5050^2 = Ans.

I do not know of any practical use of this operation. The only use I know of same is to give to some boy to work on for a few hours just to get rid of him. There cannot be any great need of such knowledge since I have up to date failed to have anyone give me the answer; college professors *et al.*

One more query. Is not the sliding rule a modification of what are know as Napier's Bones? If so what advantage is derived from the use of same, i.e., is it any quicker, and more reliable than the logarithmic tables? W. N. HAMMOND.

Repairing a Duplex Pump

I had been working at my trade about two years when word was sent in that a duplex boiler feed pump had been frozen and that they wanted some one to look it over to see if it could be repaired. The boss sent me.

The pump was a Buffalo pump, with 4x6-inch steam cylinders, and was in bad shape. Both steam cylinders were cracked and bulged on the under side. They were using it to feed a 75 horse-power boiler so that I immediately decided that it was more than large enough. The steam end was cast integral with the frame; the water ends were bolted to flanges on the frame. The glands on the steam end were screwed into the heads. After looking it over carefully and making mental calculations of what we had to do with in the shop I decided we could repair it for $25. The price was accepted.

The first thing the boss said when I got back was: "You can't do it." My explanation to him will be clear from the manner in which the work was done.

We had a 28-inch sliding-head drill press and quite an assortment of boring bars fitted to it. I first unscrewed the glands or stuffing boxes from the cylinders; then I picked out the best boring bar I could find, made a bushing to fit it, threaded the bushing to fit in the hole in the cylinders, then removed the water cylinders, and set the pump on the base of the drill press, steam cylinders up. In this position I carefully trued it up in all directions by using a tram in the boring bar. I then rebored one cylinder ¼ inch larger in diameter. The other cylinder was treated in like manner.

While the cylinders were being rebored I took a piece of scrap 4-inch cast-iron water pipe, put the coupling boring yokes on the lathe, put in the pipe and a boring bar and bored out the pipe, taking out as little as possible to get a good clean job. It finished about 3 15/16 inches I think. I next put the pipe in the chuck and cut it into two pieces of the right length for the bushings I wanted. Next I put the bushings on a spider arbor and turned one for each cylinder, making them a pressing fit. The ports were next laid out and cut. I then put a line on the outside of the bushings, running the whole length, also a line on the flange of the cylinders for convenience.

The bushings were oiled and pressed in. The lines acted as a guide to tell whether they twisted during the operation. They did not.

While I was doing my work the boss made a snap ring pattern so that I had

castings for new rings when I wanted them. I took the old pistons, turned them down, cut the grooves deeper and put in the rings. The rods being worn I took some coppered bessemer rod and fitted the steam and water pistons to the ends, fastened the valve operating collars and assembled the pump, set the valves and turned on the steam. A nicer working pump could not be desired. The total cost was $24.50. I saw this pump five years after, and the engineer told me that he had never done anything to it since but repack. I can hear some of those who read this say: "How was it done at the price named?" Let me say that in those times men did not think so much about running two or even three machines at once if by so doing they could gain in time; then too we only charged 50 cents per hour for work.

G. L. MARTIN.

Annealing High-speed Steel

Mr. Viall states, at page 889, that my failing is to leave too much to the imagination. I will ask the reader to follow me to the different pages and see who leaves things to the imagination of the reader. In his first statement, on page 534, Mr. Viall says that it does not make any difference whether it is Novo or any other kind of high-speed steel, the secret of annealing is to get it to a high heat and then let it cool without coming in contact with the air. He tells us to pack it snugly in a pipe filled with lime, one inch larger than the work. It is true that he says, to heat slowly; but he says that it requires but from 10 to 20 minutes for him to heat a piece of ordinary size. Now is it possible to heat a piece to more than 700 degrees Centigrade, packed as Mr. Viall has instructed us on page 534? Does this not disprove his statement that the secret of annealing high-speed steel is to get it to a high heat?

Then he makes the statement that he does not consider it necessary to have an elaborate apparatus to anneal high-speed steel, although I made no reference to such. It is true I gave the degrees of heat and color, but I gave that so that anyone might have positive information to work by. On page 534 he asks me to try a piece after annealing by heating to a low red. I must confess I know of no color by that name, and I would hardly go to looking for a low red above 750 degrees Centigrade, at which point there is absolutely no change in any high-speed steel. An additional 100 degrees Centigrade will make the steel so it cannot be machined very easily, but we are considering the annealing and hardening of tools. Such hardening as he speaks of cannot be considered any more than we could the case-hardening or carbonizing of machine steel for tools.

Mr. Viall says my chief failing is to leave a good deal to the imagination of the reader or take it for granted that the reader knows what I mean. Then he says I did not state how to cool the work after reheating it to get it out of the lead, and he fears it will be putting the steel back to where we started, or nearly so. Lead melts at 327 degrees Centigrade, in which case he would have 473 degrees Centigrade between the melting point and the starting point. If the lead gets to 750 degrees Centigrade before the work is all removed, I would shut the fire off. I usually take my work out as soon as it is heated sufficiently to clear well. As to the cooling of it after it is taken out of the lead, that can be done in the oil or it can be left to cool itself.

C. U. SCOTT.

Cutting Premium Rates

The remarks at page 923 of one who is having experience in producing work at a great decrease in cost, due to installing the premium system, and whose employer is simultaneously congratulating himself on the swelling of his pocket-book and regretting that his employee is doing better than he considers necessary, only confirms, in my opinion, the fact that but few managers can see that best results are obtained only when good, substantial chances are offered to the workman. At the outset I wish to be understood as being absolutely of the belief that it is for the employer's best interest carefully to establish a standard permanent price or time limit, and give a percentage of the amount saved to the workman, a plan similar to the one devised by the editor of the AMERICAN MACHINIST.

I believe if the original price or time limit represented the lowest time of the average man working steadily, then an increasing percentage for each dollar saved would yield best results.

It seems, however, impossible for the average manager to have any confidence in his cost records or in his ability to judge what represents a good day's work; and consequently he first tempts the workman by giving work out at a fair figure, to show him what he can accomplish, and then punishes him for doing so by a reduction in price or time allowed. Thus incidentally and stronger than in words, he advises the workman not to strive too hard in the future. With regard to this problem, I am in a peculiar position, being a foreman, and having about one hundred workmen in my department, to whom I give out work on the old direct piece-work basis; while endeavoring to be fair, I cut occasionally, having full control of my men's wages. My employer has adopted a modification of the Halsey premium system in piecing out work through departmental foremen: but where more than a fair saving is effected, the inevitable result, as in most other shops, is a cut on the next lot of machines. Consequently I cannot in my position guarantee a *fixed* theoretical price and a percentage of the saving of the workman, but must put out the work so that the total allowed the men shall not exceed that allowed myself.

I have therefore come to these conclusions:

1. Day work is generally bad, because men have little inducement to do their best.

2. Direct piece-work also is bad, because of the inevitable cuts in most cases, and more especially in the uniformity of cuts; i.e., an especially efficient man engaged in one class of work and who has accomplished a wonderful rate of production is cut to such an extent as to make his total wage approximately the same as that of another man on other work who is inferior or "wise," and who is only making a fair (to the employer) excess over his nominal day wage.

3. The Halsey system is all right; but as managers will not live up to it when a workman gets more than the employer desires, even though the cost per piece is reduced, I have come to the conclusion that to meet these conditions it is necessary to establish a fixed theoretical price or time limit and give the workman a decreasing percentage for each dollar saved.

In case the original figure is not greatly below the actual cost of work as produced by day time, the workman knows there is a little in it for him if he goes a trifle harder than heretofore. In case he pushes exceedingly hard, he, of course, fares better. There is, however, this feeling when two men are working side by side on the same class of work: the one who turns out the most gets paid less per piece than the one turning out the lesser amount. This is, of course, also true of all systems, except the direct piece-work or the "increased percentage of saving" scheme; but the average workman, I believe from my experience, would rather have a fixed theoretical figure which in effect was being automatically cut by himself, but which positively in case of increased production gave him a slight increase over his daily earnings than another system, which continually resulted in the lowering of his daily wage, due to the incorrect cutting by the manager. What is apparently required is a system which will pay men for what they produce, and not for the time they spend in the shop.

A. B. SMITH.

The Editor, in his comments on W. P. C.'s article, page 923, covered the ground entirely. The manager is wrong in assuming that a man with a 25-cent salary is presumably a 25-cent man.

We had three men on turning a certain machine part, time limit 18 hours. One man made them regularly in 12 and 14 hours, but it was seldom that the other two came within the time limit. We tried several, but he had them all beat and we thought it to our advantage to raise the good man so he would be sure to stay with us.

It should be clear to anyone that if only one man or a very few are able to materially raise their pay in open competition, they are entitled to all that's coming to them, but unfortunately human cussedness will sometimes assert itself to their detriment.

A day's work taken by itself as a standard is not a reliable factor for time limits. The time for turning a certain size pulley by day was 27 to 30 hours, and had for years been considered fair.

I came on the ground with a premium system, set the time limit at 10 hours and nearly got strangled. I stuck to it and after a month or two they came through in 6½ to 7 hours, and high-speed steel had nothing to do with it. Day work on turning a crank shaft took 150 to 160 hours. I set the time limit at 110 hours and after a few had been made time was reduced to a little over 50 hours. The man on this job had a peculiarity in that he did his best to just cut the time in two, not a minute better would he do. We had no one in the shop that could equal him, so on his class of work we had to set limits rather high to give the others a chance.

This thing of one man being so much better than others is a continual bother to those responsible for time limits. Mr. Authority will come out and want to know why we pay Jones so much. We say he is a superior man and of course are told we ought to know enough to get more of the same kind and cut the pay. Perfectly easy, you know.

If W. P. C.'s manager will stand for a 33⅓ per cent. increase over day pay he is in a class by himself. I never found one that would. Taking hold of a new job as super it was decided to start piece or premium work. From my experience with both piece and premium I believed more in the latter and explaining it to the manager, he suddenly wanted to know how much it raised the wages. I told him the last place I was in it amounted to 2¾ cents per hour average. With that haughty dignity that only a manager can assume he said: "Mr. ——, if such is the result of your work we do not think you are the man to look after it for us."

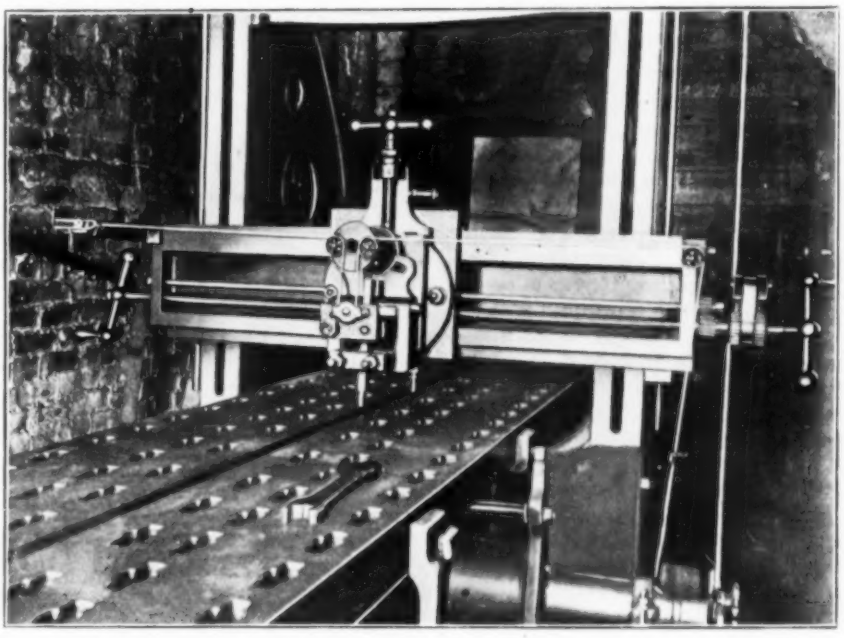
Later on he was convinced of talking foolish, but I mention it because the possible extra production did not interest him in the least, only the wages. W. P. C.'s article is interesting in another way. A method of accounting is used that is new to me, and different from the half-and-half plan. By all precedents we should have had another name prefixed to premium, but wonderful to relate it is actually called Halsey's.

A time back it seemed no end of different individual plans of premium systems, when as a matter of fact all premium systems are one and that is, Halsey's.

H. A. PATIUS.

Lifting the Planer Tool during Return Stroke

Here is a device that we have in use on a 36x36-inch by 10-foot planer. The photo, "which was taken some time ago," will give a general idea of its construction and show also that the tool will lift, no matter where the tool head is on the cross-rail.



RIG FOR LIFTING PLANER TOOL.

With the exception of the two end brackets it was made up of whatever came to hand. The piece fastened to the apron is made of two 6-inch pipe flanges and a piece of 1¼-inch pipe. The inner flange has a slot to allow it to slip under the nut that clamps the apron; the outside one has two pulleys which run freely on screws set firmly into the flange.

The part on the tool box is made of a pulley block riveted to a piece of plate iron 1 inch thick. Two holes in the plate allow it to go into the ends of the tool-holding bolts, and should not be clamped tightly. A close-fitting nut keeps it from coming off.

The brackets for the ends of the cross-rail, are clamp-shaped on the inside end, being secured to it by one set-screw, which makes it easy to set on or off. The one on the workman's side is usually off when not in use. The brackets should be of sufficient length to have the cord parallel with the rail. For operating it, the end of the cord is attached to the reversing motion, in this case by a clamp; and as it does not interfere, it is never removed.

For vertical cutting of a considerable depth some provision for altering the length of the cord is necessary, and for very heavy tool boxes and tools a partial counterbalance would be useful.

STANLEY.

Arithmetical Short-cuts

After reading "Arithmetical Short Cuts," which have appeared from time to time, I have drawn the following conclusions, and I know other readers who have done the same. Mathematicians laugh at them; waste of time to read them; space devoted to them goes for naught.

At page 22 F. H. C. treats the subject thoroughly in a splendid manner from a common-sense point of view, showing that short-cuts are valuable to those only who are constantly making calculations. In the same issue Mr. Hicks takes up the subject in an excellent way and covers the ground thoroughly, showing that all short-cuts for squaring numbers, are based on the algebraic formula,

$$A^2 + 2\,A\,B + B^2.$$

After reading these excellent criticisms, I drew the inference that they were tired of reading these short cuts, just the same as I am. Draftsmen and all those making frequent calculations have short-cuts of their own. They adopt methods and use formulas in such a way that their work is greatly simplified; and they do not put on any flourish by calling their methods short-cuts.

For a number of years I have used the method mentioned by Mr. Hicks, and I

always took for granted that everyone knew how to apply the formula

$$A^2 + 2AB + B^2.$$

I have never seen any short-cut for squaring numbers that was not based on this formula and simply put into arithmetical form to make it appear a short-cut.

O. M. HAMILTON.

Cold-rolled Steel Rings

I was very much interested while reading the article under the above heading on page 566, by Egypt. It may be interesting to some of the readers and to Egypt to know how this ring originated. It is used as the rim of a built-up hand wheel for switchboards. Most of the rings are copper plated and polished; others are painted black. Formerly they were made of white-metal castings. The trouble we had was bad castings; the sand and blow-holes could not be detected until the rings were being plated, then the loose metal fell out of the holes and caused the castings to be rejected. Another objection was that many taps got broken while tapping the screw holes for fastening on the spider.

The job was to be transferred to my department to do in lots of 500 on semi-automatics, and I did not want it. I started in to get something to replace it. I got a piece of ¾-inch brass tube, ⅛-inch wall, and formed it on the mandrel, then had it sawed and straightened. I took it to the assistant superintendent and told him that we could make them on the lathe by winding a bar on the mandrel and sawing it into rings. He had the sample soldered and polished. It finished up fine. We talked over the cost of manufacturing and price of tubing. He asked if I could make one of cold-rolled steel. I told him I would try.

I had only an 18-inch and a very poor lathe hand. I told the lathe hand what I wanted and to get ready. I must admit I was surprised to come back and find him with two helpers and one turn on the mandrel, using the back gear to hold the spindle while they bent the rod with a piece of pipe slipped over the end of the rod, making a long lever. I had them bend one more turn and found after the pressure was taken off that there was very little spring. I had them sawed, straightened in the vise and brazed. The only polishing required was at the joint. The steel rim was considered cheapest and was left in the office to be passed upon. It was forgotten for about two months, until a lot of 500 white-metal rims were scrapped for bad castings and stock had run down in the store room. One of the several assistant superintendents remembered seeing the steel rim and he called to find what had become of it. I told him it died a natural death in the superintendent's office. After hunting a while he found it in one of the drawers. He issued an order to the tool department to make the mandrel like Fig. 1 with the steel clamp to hold the end of the rod while starting. He also ordered 50 to be made and finished.

They made the mandrel to take a 16-foot rod. The stock was wound as received from the stock room. After slotting, the rings were heated to dark red so as not to scale, placed between two plates on the regular arbor press and straightened. The tool-department foreman suggested re-slotting after they were straightened out and a washer brazed in joint. This was a decided improvement. They turned out three rings an hour, including all operations up to polishing.

I did not get the job, as my department was not equipped for doing such work. The foreman who got the order for the first 500 did not have a large lathe, so he sent that operation to another department and had them milled in another. If they could not get a saw 1/16 inch thick, they took one ⅛ inch, as it was only to cut them off. He did not have a suitable furnace to anneal them, so he sent them to the blacksmith with written orders to anneal. They were placed in the fire and taken out red hot, scaled of course; but that was nothing—the polisher could fix that. He did not have an arbor press, but the blacksmith had a steam hammer, and that was certainly quicker. The next operation was to re-slot. Those done with ⅛ saw did not clean up, but that would not hurt, as they had to be brazed. He knew how to braze (had done it often). The washer was put in the joint and brass was melted around the joint, which was then filed up ready to drill and tap the holes. Some happened to fall on the floor and the joint sprang open. This caused the ring to be pronounced no good and too expensive to make.

After a few days the operation, especially the brazing, was looked into and watched by the assistant superintendent. As the sample made in the tool department was O. K., no reason was found why the others should not be right, if properly made. I saw quite a number made while I worked in that shop. I am glad to hear that they are still using them, as I considered them a good, cheap rim.

One of my friends started in to draw up a hand wheel for general use, made of steel tubes with tubular arms and steel hub, like Fig. 2. He had too many joints and I helped him to decide on the style shown in the sketch. The drawing was sent in to the engineer to decide on. We thought that there would be too much brazing and filing, and that it would be hard to polish. His idea was to save the filing of arms and rim. It was never passed on and never tried.

I got to thinking, why do we stick to the round rim? and had one made of brass like Fig. 3. It made a good hand grip, and my idea was to make it of sheet steel. The beads were copper plated and polished, with flat center painted black. It had a better appearance than the round rim. I turned this sample into the office also, and was to hear in a few days. Months passed, and I inquired if the engineer had seen it. He had not, but it was not long before he had it. I think he has it yet, using it as a paper weight, and a remembrance of me. The flat center, I thought, would be better to rivet on the spider. This would save tapping and breaking taps, and also would be convenient if an arrow was required, or the often used words "off,"—"on."

J. MCKINLEY.

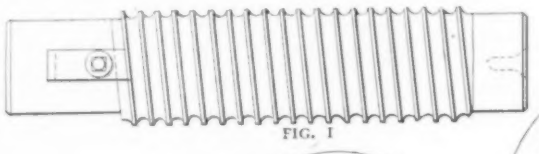
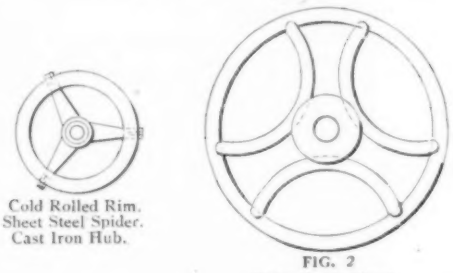


FIG. 1



Cold Rolled Rim.
Sheet Steel Spider.
Cast Iron Hub.

FIG. 2
Tube Hand Wheel

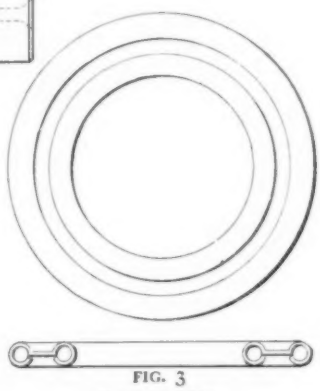


FIG. 3
Sheet Steel Rim

COLD-ROLLED STEEL HAND WHEELS

Why the Centrifugal Pump Did Not Work

In looking over the AMERICAN MACHINIST, on page 835 I noted an article on a centrifugal pumping installation in which the writer seems to believe that the action was decidedly inconsistent with the usual performance of such pumps. He stated that it would not work when the 2000 feet of discharge piping was removed and the pump allowed to discharge directly into the river.

This can readily be understood, I think, by anyone familiar with the design of

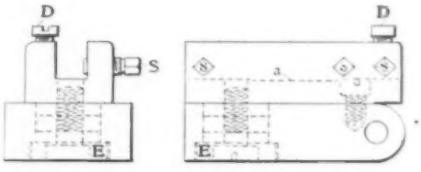
either centrifugal or turbine pumps, as removing the 2000 feet of discharge piping so reduced the head, due to friction, as to allow the pump to discharge considerably more water than it was designed for, thus overloading the driving power.

I would like to correct the wrong impression, which I am afraid would tend to reflect on pumps of this design. I wish to say further that these quantities, which seem so inconsistent, can be calculated exactly, and that this makes a very desirable type of pump when properly designed and installed.

C. W. CLIFFORD.

Planer Tool Holder

Often it happens on planer work that a high projection such as a bracket or high lug makes it necessary to reach down a long distance with the tool. This is very disagreeable and slow work as the tool, even though fed slower, will chatter and dig, seldom giving a satisfactory job when finished. It is also dangerous and costly



A PLANER TOOL HOLDER

for it is likely to dig too deep and break off or throw a chip and knock a fellow's eye out, and if the tool is of high-speed steel there is a couple of dollars gone when it is broken too short for use.

A very good way to overcome the difficulty is shown in the tool holder, which is arranged to fit in the tool-post hole, and it could be just as easily held with four screws through the four holes when the clapper is drilled for bolts and straps, as most are. The holder is of steel, heavy enough to suit the planer and work. The three tightening screws *S* are hardened tool steel, *E* is a heavy washer loose fit, and it will be noticed the seat at *A* is recessed to overcome any little curvature on the back of the tool. To make it stiffer and proof against splitting, from excessive tightening, the three screws *S* should be placed near the bottom of the tool.

It might appear that the tool would tip under and pull out from the top screws, but there need be no fear as I have given the device a severe test and it works fine; still if there be any doubt or chance of the tool *not* holding, a screw with a small head could be arranged like *D* to run down on top of the tool.

H. L. CAMERON.

Jig Details

I have just read with pleasure and profit Mr. Dowd's article, "Quick Jigs," on page 457, Vol. 30, Part 1.

The features are very good in principle and are often used. There are, however, some changes in regard to details which I would make.

The cap on the protected screw, a very good scheme, he makes as shown in Fig. 1A. If for any reason it should become necessary to remove the cap or remove the screw, which would necessitate removing the cap, it would be quite hard, as there is no way of driving out the pin. If this cap was made as shown in Fig. 1B it could easily be removed.

For cases where the conditions warrant,

FIG. 1A FIG. 1B

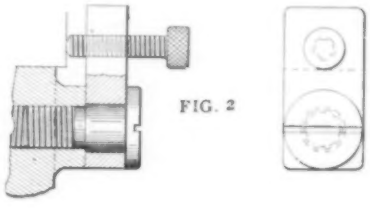


FIG. 2

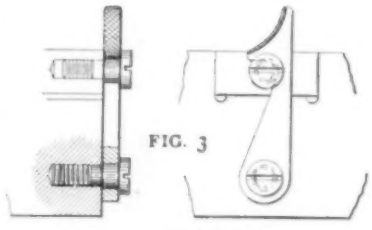


FIG. 3

JIG DETAILS

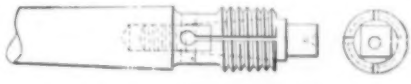
a swing latch or binder made as shown in Fig. 2, is very good. It is principally used on light drill jigs and tapping fixtures. It is of value, however, only when the center to center distance of the screws is small, the leverage being great. The swinging bush plate is quick, no doubt, but it seems to me to be open to some serious objections. The drill on entering, will, of course, hold the bush plate down on the pins. On withdrawing the drill there is not much doubt but that some of the chips would get wedged in between the drill itself and the bushing. This, of course, would tend to raise the plate from the pins. As it swings on an arc while the drill comes out straight, something would certainly happen. The pins would be open to the same objection as in the screw cap, that is, they cannot be driven out. The holes cannot be drilled through because it is necessary for the pins to bottom in order to be solid enough. The relative distances of the pins and the bushing from the swinging center are such that if the pins were slightly out of square, the bushing would be considerably more out. A quick latch that can generally be used in cases of this kind is shown in Fig. 3. The parts are all case-hardened, the latch being fitted when being assembled. One good feature of this latch not apparent at first sight is that if chips get under the leaf it will not lock. This makes the jig "fool-proof," in this respect, at least.

Jigs vary so much in size that to say never to make them less than one-half inch thick is going pretty far. Drill jigs and tapping fixtures for small, light pieces, and even for large pieces, if of aluminum or some light metal, can often be made with connecting walls one quarter inch thick, the bearing surfaces of course being much thicker. NELSON.

Mandrel for Facing Nuts

The shank of this mandrel is turned taper to fit the lathe spindle; then a hole is drilled, and turned out taper, the bottom part of the hole being left straight and tapped out. Then the thread is cut on the outside to fit the nut.

Back of the thread, two holes are drilled crosswise and slots cut into the holes.



MANDREL FOR FACING NUTS

The screw is turned to fit the taper hole, and the end is squared to apply a wrench. The end of the screw may be centered and hardened so that the tailstock center may be brought up to support it.

This kind of mandrel can also be used for turning small castings having a reamed hole. In that case, instead of the thread on the outside, the end is turned to fit the hole, so that the casting can be pushed on.

When the screw is tightened, the mandrel expands, and the nut or casting is held tight. F. C. S. STUDENT.

An English firm has brought out a new type of file, in which the teeth are cut segments of circles. It is claimed that this method of tooth formation enables the file to cut without slipping or running to the side, and insures superior cutting qualities to those possessed by the ordinary file, besides enabling the tool to retain the cutting edge for a longer period. Furthermore, owing to the shape of the teeth, which tends to urge the chips toward the outer edge, the file is said to possess self-cleaning properties, and can be used on all metals, including brass and aluminum or even marble. The file can be recut four times at a very little cost, whereby an economy of 36 per cent. is claimed over the ordinary file.—*The American Marine Engineer.*

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Is Rate Cutting Ingrained in the Managerial Mind?

This question is raised by the letters from Mr. Fernstrom and A. B. Smith, published in another column, as well as by the one signed W. P. C., published on page 924. Mr. Fernstrom was one of the first to adopt the premium plan, and one of the first to contribute his experience when that subject became a topic of discussion in these columns. His experience is both longer and wider than that of most others, and when he says: "If W. P. C.'s manager will stand for a 33⅓ per cent. increase over day's pay, he is in a class by himself. I have never found one that would"—and Mr. Smith, who also has had large experience, adds: "Managers will not live up to it when a workman gets more than the employer desires," their words have a meaning that should and will attract attention, and the more so because they are by no means the first to make this complaint.

The fundamental difference between piece-work and the premium plan is that while rate cutting is a necessity under the former, it is not under the latter. The premium plan does not make rate cutting impossible, and, in fact, no plan can do this. It does, however, make such cutting unnecessary and unprofitable; by which latter word is meant that a cheaper and a larger output will be produced if the rates are allowed to stand so long as no change in methods of production is introduced. That such rate cutting shall not be indulged in is essential to the large success of the plan, and it was the original idea of the inventor of the plan that managers would be broad-minded enough to recognize where their interests lie. Experience, however, raises a grave doubt whether this assumption is true. Over and over again it has been brought to our attention that managers will not look upon the premium earnings as legitimate earnings, and especially that they will not offset increased wages per day against reduced wages per piece and increased output, that they will not recognize the inevitable effect of cutting the rates in killing the incentive, which is at the base of the premium system, but that as soon as earnings reach a moderate figure above day wages, they cut the rates precisely as with piece-work.

The difficulty does not, however, always lie with the manager. Many times we have been told of managers who believed in the premium plan, and who recognized the necessity for uncut rates, but who simply did not dare allow earnings to materially exceed day wages for fear of criticism and worse from their boards of directors.

The difficulty, whether it is manifested by the manager or the directors, springs from a fundamental ignorance of the conditions of machine-shop work. The man who does not understand these conditions assumes that a foreman or a superintendent should be able, by mere inspection, to determine whether a fair day's output is being produced, and when under the incentive of the premium plan this output is materially exceeded, the foreman or the superintendent is immediately accused of ignorance of his business, the idea being that he should have known that the previous production was inadequate and that the increased output should have been brought about without the premiums.

The case is one of many others in which the charge of ignorance discloses ignorance on the part of the man making the charge. Nothing is more difficult in machine-shop work than judging a fair day's output. It can only be done by minute and accurate study—its determination by general observation and general acquaintance with work being an impossibility. Mr. Smith is the most successful piece-work rate setter whom we know. He seldom makes a mistake, and almost never a serious one, but he would be the first to scout the idea that anyone, by mere general acquaintance with the work, can set fair rates. If F. W. Taylor's work has done nothing else, it has, at least, shown this, that rate setting can only follow the most minute and careful study and analysis of results. Many, in fact most, will say that Mr. Taylor overdoes this minuteness of study, but no one can contend that he has not shown rate cutting as a result of general observation to be impossible.

The author of the premium plan has always contended for moderate premiums and has frequently protested that the rates which are sometimes offered are excessive, the idea being that they are higher than necessary to produce the results aimed at, and hence economically unsound. Moreover, it is manifest that the higher the rates, the greater the temptation on the manager's part to cut them, and the discussion which is going on in our columns calls renewed attention to this matter and emphasizes the necessity for moderate rates.

There is nothing to be gained by mincing matters. The premium plan properly installed and conducted leaves no excuse for cutting the rates, and the manager who cuts them destroys the very incentive which it is the prime object of the plan to introduce. Workmen are skeptical enough about all of these plans, and if rate cutting is to go on under a plan which makes it unnecessary, and by which without cutting the proprietor gets the lion's share of the results, what little faith they have will soon be destroyed. The manager who is not willing to face a future of increased earnings as an offset for a cheapened output and a larger production, should have nothing to do with the premium plan. He should jog along under day-rate methods, and be content

to see the man who knows cheap work when he sees it get the best of him as a business competitor.

Common Courtesy as a Business Asset

There is one factor in the running of a machine shop or any other business which too many of the smaller shops overlook and which we believe is more important than some of the details over which considerable time is spent. We refer to the attention shown visitors, who may or may not be possible or probable customers.

When a man opens an office door and finds himself in a coop made up of a counter on one side, hen netting on the other, and a greasy gate in front of him, with no chair or even a nail keg to sit on till someone heaves in sight, he doesn't get the best kind of an impression of the place.

Then, as too often happens, the clerks take on a spirit of industry or the six-dollar-a-week typewritist jokes with the office boy about the color of his necktie or the style of his hat, all in the belief that he is just a drummer with something to sell and hasn't any right on earth anyhow.

Finally, the office boy condescends to take his card, and after feeling to see whether it is engraved or not, he starts out in the shop after the boss.

Meanwhile the visitor is standing in the coop—probably warm physically and getting red hot inside.

This isn't exaggerated a bit, and in more than one case it has lost a good-sized order though the proprietor may have never known it.

It isn't necessary to provide a plush rocker and a box of cigars or have an elaborate library for guests, but it is common business decency to have a place where they can wait with as little discomfort as possible until you can see them.

And its a good plan to remember that a visitor's time is probably as valuable as yours, that he is as anxious to get through and go away as you are to have him—and it isn't a square deal to keep him waiting a minute longer than necessary. It doesn't impress him with your importance half as much as it does with your lack of business methods, for he knows that in the largest offices it is easy to see the right man without undue delay.

Suppose he is a traveling salesman. Your own goods have to be sold somehow, and you wouldn't appreciate your man's time being wasted or his being treated like a yellow dog. Kind of reflects on the man who sends him out, and it hurts.

There is room for quite a little missionary work in common courtesy of office help in some places, and it hurts the reputation of a firm when a buyer has to stand around and await the pleasure of an office boy or a pert clerk.

One specific case will suffice.

The buyer for a large Japanese house went to order a large quantity of metal boxes, and went through just the experiences described. Absolutely no attention was paid to him for fully twenty minutes, then he was referred from one clerk to another until even the Japanese outward calmness began to get ruffled, for it was a trifle annoying for a man of education and business standing to be treated in this way, especially when he had a big order to place, and which he finally placed with another house solely on this account.

Every visitor has a right to receive common courtesy, and it pays in dollars and cents to see that he does so. Even though he tries to sell you something you don't want, it pays to be courteous, and it often happens that you get valuable information in this way.

The Machinery Club

The Machinery Club, of the plans for which our readers have already been informed, seems now to be an assured success. The organization is complete and quarters have been engaged in the Fulton Terminal Building of the Hudson & Manhattan Railroad Company, which is now is process of erection and which is expected to be ready for occupancy April 1 next. Two floors—the twentieth and twenty-first of this building—have been engaged, and from present indications the nineteenth floor will also be required. The club will be primarily a lunching club but it is expected that it will become a general rendezvous for the machinery trade of the city and indeed of the entire country. Unlike other downtown clubs this will probably have a few sleeping rooms for the use of out-of-town members.

Five classes of members have been provided for in the plan of organization, these being honorary members; resident members, consisting of those residing in or having a regular office on the island of Manhattan; suburban members, consisting of those residing or having a regular office outside of Manhattan Island, but within 15 miles from New York City Hall; non-resident members, consisting of those residing or having a regular office outside of the suburban membership limit, and army and navy members, consisting of commissioned officers of the Army and Navy of the United States, either active or retired.

The officers of the club are F. H. Stillman, president; R. C. McKinney, vice-president; Walter L. Pierce, treasurer; and Theodore Waters, secretary.

The election of Mr. Stillman as president is a well merited recognition of his untiring efforts in the organization of the club, of which, indeed, he was the original proposer. The club bids fair to be the most important of its kind in the city.

The temporary office of the club is at 26 Fulton street, New York.

New Publications

RAILROAD MEN'S CATECHISM. By Angus Sinclair. 200 pages, 4⅜x6⅜ inches. Angus Sinclair Publishing Company, New York. Price, $1.

The catechism style seems very popular among railway men, and the questions in this book are a series used by a large railroad for the examination of its engineers and firemen. They have been developed from a code used by the Traveling Engineers' Association, but changed to suit modern conditions of rolling stock and of operation. The regulation train signals are given from the Standard Code of the American Railway Association, and it should prove a valuable companion for any railroad man who may not be quite certain on old points. The questions include air brake, compound locomotives, electric headlights, bell ringers, blowers, oil burners and other important points.

THE ART OF CUTTING METALS. By Frederick W. Taylor; 248 6x9-inch pages, with 24 folded plates. The American Society of Mechanical Engineers. Price, $3.

Mr. Taylor's remarkable presidential address, portions of which have been reprinted in our columns, met with such an immediate demand that the original edition was exhausted almost immediately after publication, and this second edition is now offered for sale to the general public. Unlike the first edition, this is supplied in cloth binding, and it is in every respect a much more substantial and durable production than its predecessor. It is unnecessary to characterize the book, as our readers are already well aware of its nature and merit. It has been received with a chorus of approval by engineering periodicals throughout the world, the recognition of it as a production of the first order of merit being universal.

The automobile has created a large demand for manganese-bronze castings. Nearly all of the leading makers are now using them upon their cars.—*The Brass World.*

Obituary

George Rowland, son of Thomas Fitch Rowland, president of the Consolidated Iron Works, died at the home of his father July 8. Mr. Rowland was a mechanical engineer, and was employed by the Consolidated Iron Works. He was 42 years old, and was a member of the American Society of Mechanical Engineers.

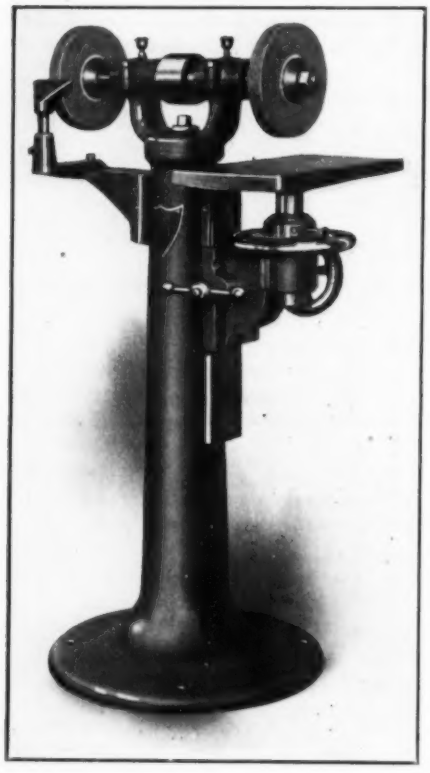
New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

Micrometer Feed Surface Grinder

The surface grinder shown in the accompanying half-tone is intended for general use in tool room or shop for fitting keys, sharpening punches and dies, and for the many small jobs always on hand to be filed or ground.



MICROMETER FEED SURFACE GRINDER

Especial attention is directed to the arrangement of the work table. It has a quick adjustment of the knee on the column by means of a rack and pinion operated by the hand-wheel at the right, and is clamped in place by the hand nut shown at the left. The table is carried by a stiff post which moves vertically in the knee, and is prevented from turning horizontally by a fixed key. The hand-wheel, as shown, encircles this post and provides a fine adjustment of the table for the depth of cut. This hand-wheel carries a large dial graduated to read in thousandths of an inch; though as the graduations are over an eighth of an inch apart, finer adjustments may be easily obtained. A dust ring protects the elevating screw and post bearing from injury by emery dust and grit.

The table is 8x14 inches and has a vertical travel of 12 inches on the gibs and ¾ inch by the micrometer. The spindle is 1 1/16 inches in diameter and runs in cast-iron bearings at 3000 revolutions per minute. The part of the spindle upon which the wheels are clamped is ¾ inch in diameter. The belt pulley is 2⅛ inches wide. While grinding wheels seven inches in diameter are furnished and recommended, nine-inch whels can be used. All bearings are adjustable for wear. A vise is furnished for holding pieces too small or irregular to be slid on the table. The spindle center stands 38¾ inches from the floor. The net weight of the machine is 300 pounds. It is made by the La Salle Machine and Tool Company, La Salle, Ill.

The "Plurality Die" Bolt Cutter

The general arrangement of this machine is shown in Fig. 1, the back view showing more of the details than the front.

The principal feature is the die, shown separately in Fig. 2. This has a number of cutting points on the outside of the tap-like cutters, the number of these points varying from 8 to 12, according to the size bolt to be cut. Cutters with 12 points are shown in Figs. 2 and 3.

This enables all the common varieties of bolts to be cut with one or two sets of dies, the cutters shown in Fig. 3 handling from ⅝ to 1½ inches, with two points for several sizes so as to give different pitches of threads when desired. If a machine is only to be used for a few sizes, these points can be for the same bolts, so as to have a number of duplicate cutters always on hand.

All points of the same size are interchangeable either on the same set of dies or of the same number on any other die. Three cutting points are used as they seem to distribute the work well, and the stock is more readily held in the center. The dies can be easily sharpened by grinding on a V-shaped wheel.

The die is held firmly by a tempered steel bolt or stud, with a notched head on the back, these notches corresponding to the points on the die and engaging a circular rack. This makes it easy to change the points for different-sized bolts as they are not removed for this purpose, but simply loosened, pushed back to disengage the notches and turned till the point wanted comes to the cutting position. A spring then pushes the stud forward into place, and it is tightened as before, the whole change being made very quickly. If desired, the dies can be adjusted for size, without stopping the machine, by turning the handles shown behind the die head. The ring is graduated so that the

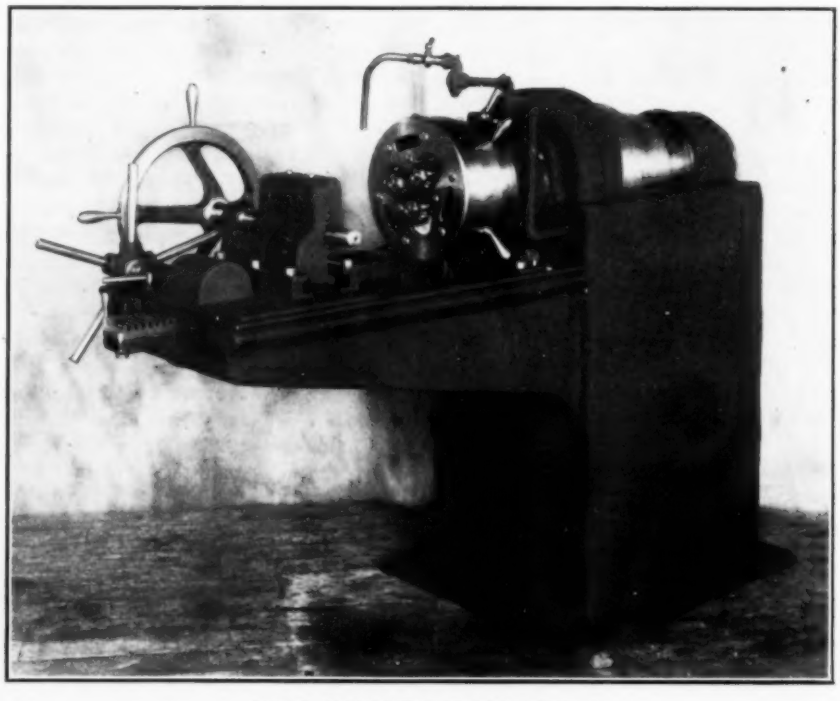


FIG. 1. BACK VIEW OF BOLT CUTTER

amount of adjustment is easily determined.

The back gears are under the machine so that no gearing is exposed. There is a positive automatic throw-out, and a device for closing the die at the required point is also added, if desired. The front bearing is long and close up to the head, the take-up for wear being by a taper in this bearing.

Ample provision is made for flooding the work with oil and disposing of the chips. The oil pump works in either direction, so that lubrication is assured

FIG. 2. THE DIE WITH CUTTERS IN PLACE

FIG. 3. TWELVE-POINTED CUTTERS

whether cutting right- or left-hand threads, without changing the belt. The machine is built by the Mummert, Wolf & Dixon Company, Hanover, Penn.

Heaviest Passenger Locomotive

The American Locomotive Company has just completed for the Pittsburg, Fort Wayne & Chicago Railway a Pacific-type passenger locomotive, which is about the largest yet put into service on any line in England. It has 80-inch driving wheels and cylinders 24x26 inches, giving a tractive effort of 31,000 pounds, with 205 pounds boiler pressure. It has 4427 square feet of heating surface, and a grate area of 61.8 square feet. It weighs 177,700 pounds on drivers, 45,000 pounds on trucks, and 45,300 on the trailer, or 268,200 pounds in all.—*Mechanical Engineer.*

The sewing machine chiefly sold in Greece bears a well-known American name, but is manufactured in Scotland. It was introduced here in 1882, and the progress which the business has made is shown by the fact that 34 agencies are now maintained in Greece, 5 in Crete, and 11 in Epirus and Albania.

Something New in the Measurement of Power

By an oversight we neglected to state in the article describing the method of using the electric motor as a dynamometer in the laboratory of Henry Souther, page 1, that this apparatus was installed under the direction and at the expense of the Association of Licensed Automobile Manufacturers, in connection with its systematic work in the improvement of automobiles.

Things to Think about

By John R. Godfrey

Did it ever occur to you that a machine with power feed appliances for the various adjustments would not only do more work in a day, but could be depended on for a better class of work as well? That was a poser I ran up against the other day; and yet when you come to think about it, it looks very sane and reasonable after all.

Take the head of a boring mill or planer and try winding it a foot or so along the rail. Makes you think of winding a winch in hoisting a safe to the tenth floor of a skyscraper. Means more power than you think until you see the size motor they put on to do this work by power. Then you think your back aches worse than ever.

Making It Easier

You don't do this many times before you come to believe the gibs are tightened up a trifle more than they need to be, and you promptly loosen them, wondering the while, why you didn't think of it before. And this is what affects the accuracy of the work, for lost motion is introduced and the work suffers.

With power at hand for making these adjustments, the machinist keeps the heads tightened up so as to prevent all shake and lost motion, and turns out better work. He also saves more time than the difference between the speed of hand and power adjustments, for it takes a man of husky frame to wind a heavy planer head along a rail any considerable distance without having to stop and get his breath afterward. Seems to me there's no question about its paying to put power adjustments on many more tools than we do. Why not on more lathe carriages and tailstocks?

Getting Raised or Fired

The question of wages is always with us and has many sides. We all want all we think we are worth, and are not wholly satisfied unless we get it—then we are apt to feel that we are worth a little bit more.

There was a superintendent of the old Taunton Locomotive Works, who had a rather peculiar idea on the subject. When a man asked him for a raise he either got it or was discharged; there was no middle ground. His logic was this wise:

"He thinks he is worth more money; consequently he will never be entirely satisfied unless he gets it. If you think he is worth more, raise him. If not, the sooner he gets another job the better, as you don't want a man who is discontented."

This was rather a tough proposition for the man who didn't know his policy, as it was a case of taking your job in your hands when you spoke a word on the great financial question.

Different Ways of Asking for a Raise

This recalls another case which has a more direct bearing and shows that a worker of any kind is more or less of a salesman, and the better he handles the subject the more he is likely to get.

Suppose an agent of the American Machinist came to you and said: "If you don't pay me a dollar more, I'll cut you off the list next month."

Would you calmly produce the other dollar or request him to visit the regions of eternal warmth? If you felt you must have the paper anyhow, you'd pay the extra dollar; but 'twould leave a bad taste in your mouth, and you would get along without it at the first opportunity.

Suppose on the other hand he told you something like this:

"We have made the paper better than it was in several ways; have spent money to get information that will help you increase your output; and it will pay you to take it even at the higher price, because it is worth more."

Wouldn't you feel more like paying the raise in price; or, if you couldn't, wouldn't you feel that he was a decent sort of a chap anyhow?

It's the same way in asking a raise in wages. No man likes to be hit with a club, and he is very apt to fire a man on the spot when a demand of this kind is made. If a soft answer turneth away wrath, so a decent request prevents stirring it up and leaves the atmosphere clearer whether the request is granted or not.

Open and Closed Shops

This doesn't refer to the labor question in the least, but to shops whose "secrets stay securely hid" behind closed doors with "Positively No Admittance" plastered all over them.

I don't say there are not places where it's a good plan to keep everything under lock and key, but I am sure that in most cases it is entirely overdone and that the so called secrets have been known for years.

I was brought up on a certain make of lathe, among other tools, and came to have a real affection for it, for it was a well made tool, and did good work. So when I took a trip to the section where it

was made, that shop was my first calling point. There was a "No Admittance" sign, but I proved my interest with a tale of the lathe and its work, and was allowed within the sacred portals.

And I've been sorry ever since.

Youthful ideas of system and modern methods were shattered the minute I got inside the door, and there wasn't a single thing in the whole shop worth seeing. The marvel is that a firm like this could build such a good lathe and make a living selling it.

GUARDING OLD METHODS

Similar cases exist today in many shops. Only recently I was privileged to see the workings of a very modern shop, and found certain punching processes carefully guarded from the public at large. Yet these same processes have been illustrated in the AMERICAN MACHINIST as much as five years ago, and are used in similar work in several other shops.

The same thing probably holds good in many other lines of work, and we guard as secrets, methods that are known even more widely than our own name or the machines we build. Many believe that they gain much more than they lose by a free interchange of ideas, as they can draw from the experience of many in exchange for one experience of their own.

It is this broad view which makes it possible for a maker of boring mills, for example, to go openly to such a shop as Bullard's and see the whole plant. Isn't that much better than hiring your wife's first cousin to sneak through under pretext of being a possible buyer? And who believes they are the losers by such a liberal policy?

Personal

Frederick A. Waldron, who has supervised the installation of machinery and power plants for many of the leading firms, announces the establishment of an office at 37 Wall street, New York, as industrial engineer.

Oscar Winter, who for more than six years has been steam expert of the National Tube Company, formerly the Lorain Steel Company, of Lorain, O., has opened a consulting engineer's office in the Rockefeller building, Cleveland, O.

Trade Catalogs

Scully Steel and Iron Company, Chicago, Ill. July and August stock list. Illustrated, 4½x7 inches, paper.

Brown & Sharpe Manufacturing Company, Providence, R. I. Booklet on gears, castings and circular pumps. Illustrated, 12 pages, 3½x6 inches, paper.

Ingersoll-Rand Company, 11 Broadway, New York. Bulletin No. 2010, describing "Crown" pneumatic hammers. Illustrated, 24 pages, 6x9 inches, paper.

Union Twist Drill Company, Athol, Mass. Catalog D and Book of Information on gear and milling machine cutters and similar tools. Illustrated, 158 pages, 4½x7½ inches, paper.

Clark Automatic Telephone Switchboard Company, Providence, R. I. Catalog M, describing automatic interior telephone systems. Illustrated, 12 pages, 6x9 inches, paper.

Fort Wayne Electric Works, Fort Wayne, Ind. Bulletin No. 1096, illustrating and describing Type A transformers. Bulletin No. 1004, illustrating and escribing belted direct-current generators, Type LF.

Manufacturers

The Oscar Lear Automobile Company, Columbus, Ohio, will move to Springfield.

The Industrial Iron Works, Baltimore, Md., will build a two-story addition.

The German-American Car Lines, of Chicago, will build new shops at Warren, Ohio.

The St. Louis (Mo.) Lightning Rod Company will erect a new plant to cost $20,000.

S. H. Hill, Paxton, Ill., has let the contract for the construction of a new broom factory.

The H. M. Hooker Company, paint manufacturers, Chicago, Ill., will build a new factory.

The Mobile & Ohio Railroad Company will erect a roundhouse and machine shop at Meridian, Miss.

The Eastern Steamship Company, of Bath, Me., will rebuild the machine shop recently destroyed by fire.

The Huntsville (Ala.) Railway Light and Power Company has received plans for a duplicate power plant.

The Utica (N. Y.) Drop Forge and Tool Company, whose plant was recently destroyed by fire, will rebuild.

The Bartlesville (I. T.) Foundry and Machine Company, recently organized, has secured site for its plant.

The Houston (Texas) Packing Company will erect a plant for manufacturing boxes and other wooden material.

The H. B. Smith Company, Westfield, Mass., manufacturing steam heating apparatus, will enlarge its plant.

The Burroughs Adding Machine Company, Detroit, Mich., is planning a $100,000 addition to its plant, it is said.

The American Seating Company, Manitowoc, Wis., will enlarge its machine shop, foundry and molding rooms.

The American Brake Shoe and Foundry Company has let contract for a new $40,000 plant at Chattanooga, Tenn.

H. W. Cooper, Moline, Ill., manufacturer of saddlery hardware, will build three additional buildings including a foundry.

The Weber Manufacturing Company, Jamestown, N. Y., making hardware specialties, is erecting a new factory.

The Compressed Air and Vacuum Machinery Company, St. Louis, Mo., will erect a new plant to cost over $200,000.

The E. E. Souther Iron Company, St. Louis, Mo., has purchased site for a new plant. This will cost about $150,000.

The Bernstein Manufacturing Company, Philadelphia, Penn., metallic bedsteads, is building an addition to its factory.

The Union Iron and Brass Works, El Paso, Texas, is planning to install an iron foundry for the production of iron castings.

The Bartholomew Company, Peoria, Ill., will build an addition to its automobile factory, which will probably cost $150,000.

The Chippewa Valley Electric Railroad Company is expending more than $200,000 on a new water power plant in Menominee, Wis.

The foundry building and pattern house of the American Steel Foundry, Indiana Harbor, Ind., was destroyed by fire; loss $100,000

The Oster Manufacturing Company, Cleveland, Ohio, builders of pipe threading tools and machines has let contract for a new building.

The Littlefield Chemical Gas Company, Alexandria, Ind., will equip a plant for the manufacture of heating apparatus using a new fuel.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

Let us quote you on gear cutting. Iroquois Machine Co., Providence, R. I.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

We desire a few more machines or specialties to manufacture. Box 423, Troy, N. Y.

Machines designed and built. Walter S. McKinney, M. E., Broadway, Flushing, N. Y.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

High-grade gray iron machinery castings. Write for quotations. Phœnix Iron Works Company, Meadville, Pa.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

We will do your manufacturing for you; well established and equipped foundry and machine shop. Emmert Mfg. Co., Waynesboro, Penn.

Well established concern will pay royalty for several good patented machines or tools to manufacture. Emmert Mfg. Co., Waynesboro, Penn.

Commercial artist and technical advertising, smart retouching and snappie ads.; deal direct, it saves worry. Chas. Irvine, 258 Fourth Avenue, New York.

A well equipped machine shop in New England of sufficient capacity to employ 200 men is in a position to take on more work. Box 186, AMERICAN MACHINIST.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Wanted—By machine shop, small jobs of experimental, model, and machine work, etc.; prices very reasonable; West End Auto & Machine Co, 72 West Main St., Stamford, Ct.

Men who operate grinding machines should read H. Darbyshire's "Precision Grinding," a $2 book that's worth ten times that money to you. Hill Pub. Co., 505 Pearl St., New York.

Drawings, checking and detailing done quickly and accurately by technical graduates with long experience in all kinds of a drafting and design. Address Box 173, AM. M.

Draftsmen: Clifford's book of alphabets, for titles, sign painting or show cards, valuable to every designer; limited number only; price 25 cents; write now. C. W. Clifford, 643 Belmont ave., Philadelphia, Pa.

An up to date modern foundry equipped to make large work, would like to get in touch with machinery builders who are in need of heavy gray iron castings; low freight rate to all eastern points. Address Box 187, AM. M.

A well equipped machine shop and foundry desires to add to its output by the manufacture of articles of brass and iron which

would find a ready sale in the south; correspondence invited. Box 122, AMER. MACH.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th Street.

Advice; mechanical, practical and technical: tell me your needs I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

Arrange with us to do your manufacturing; we are thoroughly equipped for all classes of machine work, including screw machine and punch parts, tools, jigs, etc.; we also design and build to order special and experimental machinery. Forest City Specialty Manufacturing Co., Rockford, Illinois.

Planer hands—C. Ashley, a planer hand, has written a book "Planer Kinks," for practical planer men and every planer hand should get it; $1 postpaid. Hill Pub. Co., 505 Pearl St., New York.

I have a machine shop (Pittsburg) newly equipped for light and medium weight machine, tool and die work; wish skillful foreman machinist and toolmaker with some good inventions to join me; my business is prosperous; good chance to get into business and make money. Address B. F. Bain, Pittsburg, Pa.

We have a special proposition for a few bright, energetic mechanics, such as foremen, draftsmen or machinists in different sections of the country; no canvassing or selling of any kind, and, while not interfering with your regular work, pays well for the time taken; we want only practical men who can be depended on to give the little time required each week; further particulars on application. Box 102, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Chief draftsman at present employed, wishes to change; specialty automatic machinery, inventing, and tools for small interchangeable work. Box 194, AMER. MACH.

Superintendent, aged 42 wishes change; 12 years' executive experience, experimental, steam specialties, interchangeable manufacturing, close tool work, labor saving devices; Bridgeport or Connecticut preferred. Box 177, AMERICAN MACHINIST.

Superintendent or master mechanic with 20 years of practical experience in both mechanical and electrical manufacturing, who is well informed on up to date tools, fixtures and general equipment, etc., for duplicate and interchangeable manufacturing. Address "Superintendent," 136 Myrtle Ave., Stamford, Conn.

ILLINOIS

Designer, who is a practical, technical, reliable and experienced man on machine tools, special machinery and tools for manufacturing. Box 196, AMERICAN MACHINIST.

Superintendent, practical machinist and toolmaker; wide experience on interchangeable work, special machinery and metal specialties; excellent manager of men; can handle big proposition and produce results; high recommendations. Address Box 143, AM. M.

MASSACHUSETTS

Mechanical engineer of wide experience along manufacturing lines, capable of managing plant, controlling costs and increasing output, desires a position as superintendent; location, immaterial; satisfactory references; member A. S. M. E. Address Box 190, AM. M.

Mechanical engineer; 28; technical graduate, shop and drafting room experience, desires position with manufacturing firm or with consulting or contracting engineers, where energy and ability are required; location, New England, Massachusetts preferred. Box 188, AMERICAN MACHINIST.

NEW JERSEY

General foreman, excellent toolmaker and machinist, designer of labor-saving devices, open for engagement. Box 158, AM. MACH.

NEW YORK

Draftsman, experienced man seeks position. Box 191, AMERICAN MACHINIST.

Mechanical draftsman wishes position. Address Box 201, AMERICAN MACHINIST.

Experienced designer; printing presses and book binders' machinery a specialty; desires situation. Address Box 198, AMER. MACH.

Wanted—A position as chief engineer, mechanical and electrical; can furnish the best of references by inquiries. Box 183, AM. M.

Valves—Hydrants and water works specialties; draftsman, designer and engineer with 12 years' experience on this line of work, is open for engagement. Box 192, AMERICAN MACHINIST.

Competent machinist and toolmaker, who has been successful as traveling salesman wants position as traveling salesman or expert operator; would start at small salary. Box 195, AMERICAN MACHINIST.

Mechanical engineer and draftsman, German graduate, age 31, wishes position anywhere; wide experience in general work; has been superintendent for machine plant with large chemical concern. Box 193, AM. M.

Superintendent and master mechanic of large experience, is open for engagement; technical education; small and medium interchangeable machinery, general manufacturing, gas engines or automobiles; excellent references. Box 152, AMERICAN MACHINIST.

OHIO

Engineer, graduated in Germany; 17 years' practical experience; machine tools a specialty; excellent references; two months in the United States. Box 197, AMER. MACHINIST.

PENNSYLVANIA

Foreman or assistant superintendent experienced on valves and fittings, machine tools, engine parts and general repair; references furnished; salary about $1500. Box 185, AMERICAN MACHINIST.

Factory executive, engineer, manager, superintendent, energetic, successful, experienced in industrial layout and organization for maximum production; member A. S. M. E. Box 141, AMERICAN MACHINIST.

Master mechanic desires change as superintendent, assistant superintendent or mechanical engineer, technical graduate, draftsman and designer, successful manager of men and organizer; good references. Box 184, AMERICAN MACHINIST.

Wanted—Position as advertising manager with manufacturing concern, preferably in mechanical field, by a woman with years of experience in that capacity and field, with large, representative houses; thoroughly competent to handle printing, illustrating and the preparation of copy; at present employed; reasons for seeking change made known to prospective employer. Box 103, AMERICAN MACHINIST.

VERMONT

Advertiser will be open for engagement as works manager or mechanical engineer on September 1. Address Box 170, AM. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Toolmakers experienced on fixtures, dies and gages. Address with full particulars as to experience, wages required, giving definite time as to commencing work. Ross Rifle Company, Quebec, Canada.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—Mechanical foremen desiring good positions with large manufacturing company, can secure same by investing from $1000 to $5000 in stocks paying 14 per cent. dividends; permanent foremen are the objects. Write quickly to P. O. Box 725, Bridgeport, Conn.

FLORIDA

Wanted—Coppersmiths, $2.80 to $4.00 per diem. Apply to Board of Labor Employment, Navy Yard, Pensacola, Fla.

ILLINOIS

Wanted—A designer of the highest grade, experienced in automatic machinery; a man with a technical education preferred; concern is rapidly growing and prospects for advancement are excellent for the right man; in replying, state age, nationality, married or single, and salary expected, also experience and references; correspondence confidential. Box 203, AMERICAN MACHINIST.

INDIANA

Wanted immediately, first-class draftsmen, experienced in water tube boiler settings and details; give full particulars and salary expected. Trade Drafting Room, Atlas Engine Works, Indianapolis, Ind.

MAINE

Wanted—A young machinist or toolmaker to travel and sell novelties in high-speed steel and high grades alloys tool steels in the way of profiled bars fluted the whole length for drills or counterbores, etc., will sell in every modern machine shop; salary with commission and traveling expenses paid; must be a hustler and able to explain the advantage of using these profiled steels. Address care "Profile," AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—A mechanic thoroughly familiar with hack saw blades manufacturing; excellent position to the right man. Address Joe Pollock, 46 Speedwell St., Dorchester, Mass.

Wanted—Man thoroughly familiar with the manufacture and assembling of small machine parts to act in the manufacturing department as assistant to the superintendent. Boston Gear Works, Norfolk Downs, Mass.

MINNESOTA

Wanted—First-class machinists on lathes, planers, floor and vise work; non union men only; yearly contracts at 30c and 40c. an hour. Diamond Iron Works, Minneapolis, Minn.

MISSOURI

Draftsman wanted—Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 867, AMERICAN MACHINIST.

NEW JERSEY

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Wanted for small shop; competent machinist and toolmaker; must be experienced and capable of installing economical shop methods, and have had charge of manufacturing in quantities. Address by letter giving full information as to experience, wages, etc. F. S., 160 Cornelison Ave., Jersey City, N. J.

NEW YORK

Wanted—Superintendent for factory in New York city, employing about 80 hands; must be thoroughly experienced in the manufacture of scientific and optical instruments, also have executive ability; no others need apply; please state experience, age and salary expected. Box 199, AMER. MACHINIST.

Toolmaker; a first-class practical toolmaker, familiar with all kinds of tool work and shop practice; experienced in handling men; a good position for the right man; write, stating age, experience both as a mechanic and in handling men, and salary expected. Address "Tools," 41 W. 34th St., New York.

Master mechanic with extended shop experience and technical education for soft metal rolling mill, to design and construct new and labor saving machinery and take charge of, repairs and maintenance of plant; one with knowledge of metallurgy preferred; highest references demanded; state experience and salary expected. Box 204, AM. M.

OHIO

Wanted—Experienced punch and shear draftsman; state qualifications, age, and salary expected. Box 70, AMER. MACHINIST.

Wanted—Several draftsmen familiar with steam hammer designing; state age, experience, and salary expected. Box 71, AM. M.

Wanted—Machinists and operatives; we are about to remove our machine shops from Kent, Ohio, to Franklin, Pa. Some of our present employees own their homes in Ohio and do not wish to leave them so are seeking other permanent employment here. We therefore offer to qualified persons positions in our present plant from now until about October first and permanent position to those who then move with the plant to Franklin, Pa. To such persons who accept service with us under the present conditions, we will guarantee the best permanent positions when our Franklin plant is in operation, giving the preference even over present residents of Franklin. Franklin is a beautiful little city of 12,000 inhabitants with excellent schools and other facilities. We have no labor troubles in our shops nor have we ever had any. Address communications to C. L. Winey, Works Manager, Kent, Ohio.

PENNSYLVANIA

Wanted—Lathe, planer and boring mill hands. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Foreman for gear cutting department; must have experience; apply with particulars to R. D. Nuttall Co., Pittsburg, Pa.

Molders Wanted—Good pay and steady work for competent and desirable men; open shop; no labor troubles. Address with full details of experience and wages expected. Box 138, AMERICAN MACHINIST.

Superintendent; by a concern manufacturing sheet steel specialties; must be a good

manager of men and experienced in the design and construction of dies and special tools for working sheet steel. Box 200, AM. M.

Wanted—Man about 35 as general foreman, shop employing 200 men, on machine tools and special machinery; must be familiar with up-to-date methods; give experience, references and salary. "X. X.," AM. MACH.

Wanted—Technical college graduate as instructor in mechanical engineering, with at least 2 years' drafting room experience, and a good scholastic record in the principles of mechanics; part of duty to assist in summer term work; state minimum salary that would be accepted; send application and references to Professor of Mechanical Engineering, 357 Market street, Bethlehem, Pa.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

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For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

For sale or will lease to responsible parties modern equipped brass foundry, located in Brooklyn. Address "B. F.," AMER. MACH.

We have for immediate delivery one new latest pattern 15" Gleason bevel gear planer. The Chas. A. Strelinger Co., Detroit, Mich.

For Sale—Ten volume library covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

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For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

For Sale—One branch of a well established line of machine tools in the middle west with good foreign and domestic agents and five months' orders ahead. Address "Special," AMERICAN MACHINIST.

One 10x10x12 duplex steam pump; one 10x14x12 Rand air compressor; one No. 3 Toledo punch press; two hydraulic presses, will take in material 35"x35". Shartle Brothers, Middletown, O.

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Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction

Electric Controller & Supply Co., Cleveland, O.

Brazing

Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

See Grinding Wheels

Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing

Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Manufacturers Foundry Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.
Keystone Steel Casting Co., Chester, Pa.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.

Centering Machines—*Cont.*

Hill, Clarke & Co., Inc., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor, Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co, New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Woods Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic

Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic

Sturtevant Co., B. F., Hyde Park, Mass.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Slushing

Warren Bros. Co., Boston, Mass.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Ingersoll-Rand Co, New York.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts

National Brake & Clutch Co., Boston, Mass.

Corundum

See Grinding Wheels.

Cotters

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Heber & Co., J. R., Brooklyn, N.Y.
Veeder Mfg. Co., Hartford, Ct.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

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Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Electric Controller & Supply Co., Cleveland, Ohio.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
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Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

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Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
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Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
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Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
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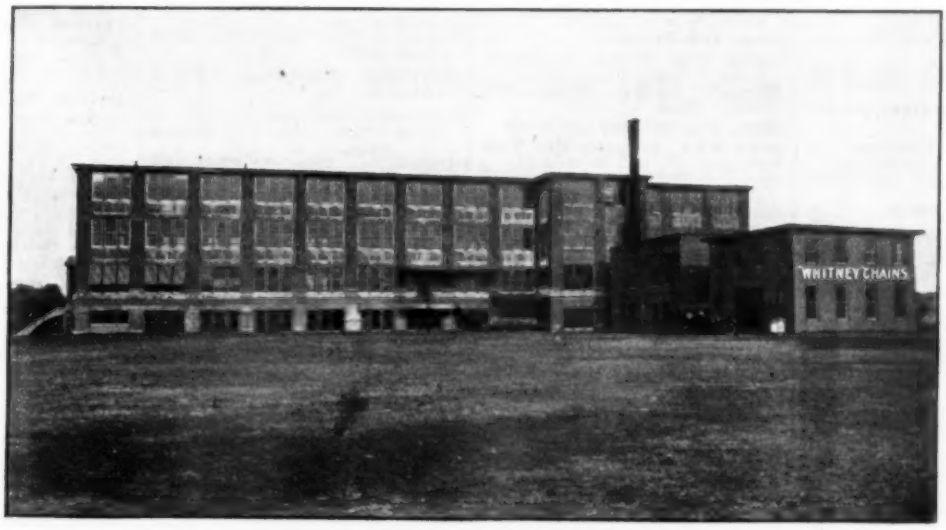

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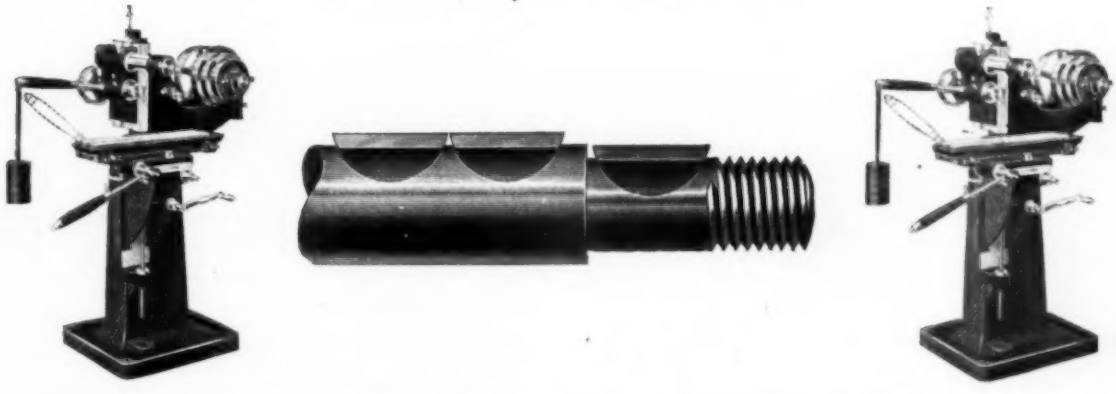

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Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

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Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O .
Winkley Co., Detroit, Mich.

Cups, Grease
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Williams Valve Co., D. T., Cincinnati, O.

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Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros. Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

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Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

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Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Cyclometers
Veeder Mfg. Co., Hartford, Ct.

Diamond, Tools
American Emery Wheel Co., Providence, R. I.

Diamond, Tools—*Continued.*
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, Ohio..
Superior Corundum Wheel Co., Waltham, Mass.

Dies, Sheet Metal
Risdon Tool Works, Waterbury, Conn.
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.

Dies, Sub-Press
Risdon Tool Works, Waterbury, Conn.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Mittineague Paper Co., Mittineague, Mass.
Noyes Mfg. Co., Waynesboro, Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler
American Tool Wks. Co.. Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, Ohio
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.

Drilling Machines, Multiple Spindle—*Continued.*
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Mach. Co., Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, Ohio.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.

Drilling Machines, Upright—*Continued.*
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Mach. Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Coates Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Dallett Co., Thos., H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Eectrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Eectric Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Eck Dynamo & Motor Co., Belleville, N. J.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Clark, Jr. & Co., Jas., Louisville, Ky.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
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American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr. & Co., Jas., Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Consulting and Architect
Thompson, Hugh L., Waterbury, Conn.

Engineers, Mechanical and Electrical
Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Philadelphia, Pa.
Merritt, Jos., Hartford, Conn.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Kerosene Oil
Remington Oil Engine Co., Stamford, Conn.

Engines, Marine
Remington Oil Engine Co., Stamford, Conn.

Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.

Engines, Steam
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers
Bormay Engraving Co., New York.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Philadelphia Bourse, Phila, Pa.

Expanders, Tube
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment
Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps
American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York.

Filler, Iron
Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.
Simplex Mfg. Co., New York.

Fire Brick
McLeod & Henry Co., Troy, N. Y.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co, Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery
Scranton Co., The, New Haven, Conn.

Forgings, Drop
Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic
Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine
Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel
Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Crescent Forgings Co., Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
McInnes Steel Co., Corry, Pa.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gas Blowers and Exhausters
Sturtevant Co., B. F., Hyde Park, Mass.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.

Gear Cutting Machinery—*Continued.*
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Morse, Williams & Co., Phila., Pa.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide
Boston Gear Works, Norfolk, Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.

The Fly Cutter in Punch and Die Work

An Original Method of Producing Complex Shapes by a System of Elementary Cutters and Milling-machine Adjustments

EDITORIAL CORRESPONDENCE

The fly cutter is commonly looked upon as a makeshift tool to be used for an occasional job for which the making of a cutter of the usual form would be too expensive, the idea being that more time will be saved in making a simple fly cutter than will be lost because of its slowness of action. The fly cutter has, however, other merits than that of cheapness. Of all cutters, it is the one which can be depended upon to reproduce exactly its shape, there being with it no question of the truth of collars or spring of arbors, or indeed of wabble due to any cause whatever. If well made and well mounted this style of cutter may be depended upon to reproduce its own shape with a high degree of accuracy.

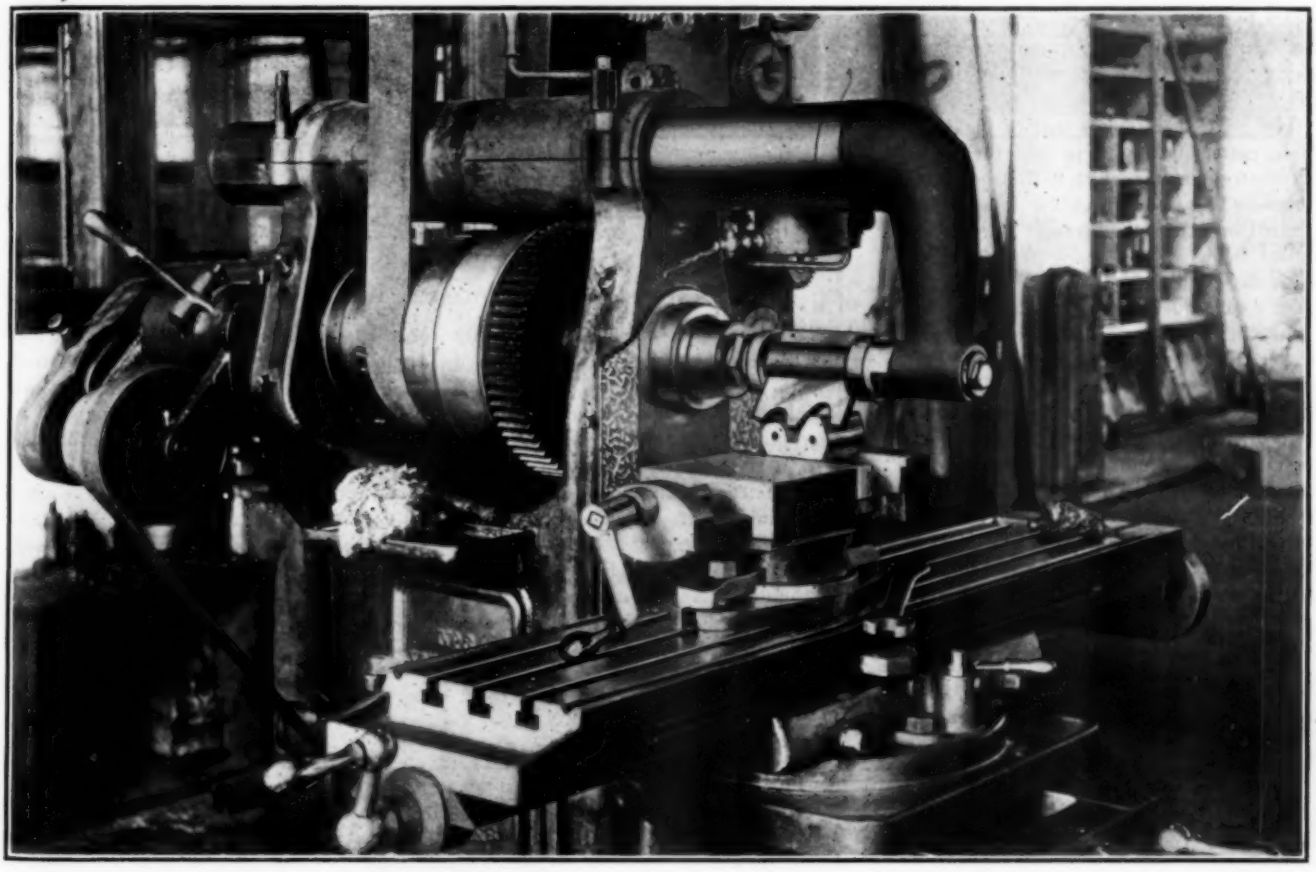


FIG. 1. A FLY CUTTER AND ITS WORK

At the Morse chain works, fly cutters are used to an extent and with a thoroughly organized system that I have not elsewhere met, and for the conditions which surround their work they perform a function for which it would be difficult to find other means. The outline of the links of the Morse chain, as is well known, is complex, some portions of the outline requiring a high degree of accuracy, while of other portions a less degree of accuracy is sufficient. The outlines are composed of a series of straight lines and circular arcs which in the completed punch are produced by a pair of fly cutters, made in turn from elementary cutters which in the end go back to the primary process of drilling and reaming a round hole or of grinding a straight edge on the grinding machine. The methods followed form a definite system of originating these complex outlines by strictly mechanical means and without hand work or hand measurements of any kind.

Fig. 1 shows the blanking punch for a 2-inch pitch chain link, the side which engages the sprocket being uppermost; mounted in the milling-machine arbor is the fly cutter which produced this punch. Fig. 2 shows the complete outline of the link, and illustrates the manner in which it is built up of straight lines and circular arcs. As the methods followed are general and do not apply to any particular size of link, the dimensions are omitted from the sketch, those needed in the following description being indicated by reference letters. In some respects the results of the method are most striking when used in connection with small punches, as no conceivable method depending upon hand lay-out could give even tolerably satisfactory results in such cases. In order to make the method clear, however, a link of large size—2 inches pitch—has been selected as the subject of the illustration. By the pitch of these links is meant the distance between the points *a* and *a* of Fig. 2. For the production of the punch two fly cutters are necessary, one for the inner and the other for the outer side of the link. The interesting feature of the method lies in the production of these cutters from the series of elementary forms already referred to, although in most cases several intermediate forms, alternately male and female, lie between the original elementary cutter and the final complex form. The outer half of the link profile being the simpler, it will be discussed first.

Taking first the arcs whose radius is *b*, the first step in their production consists

in drilling and reaming a hole in a flat piece of tool steel inclined at an angle of 7 degrees, as shown in Fig. 3, this being the uniform clearance angle which is used throughout the work. The radius *b* of this hole is the same as that of the arc which it is intended to produce, and, the hole drilled, it is a simple matter to grip the piece of steel in a machine vise—again at the angle of 7 degrees—and mill it off exactly down to its center, as shown in Fig. 4. The depth of cut is determined by first milling down carefully until the cutter just cuts through the circle, adjusting the index dial of the milling machine to zero and then feeding downward an additional amount equal to the radius *b* of the required arc, the result being the cutter shown in Fig. 5.

Of course the tilting of the steel for the clearance angle results in a slightly flattened elliptical arc for the final punch instead of a circular arc as called for in the drawing, but this is of no importance as an exact circular form is not necessary.

The next operation is that of making a male cutter by which to mill the actual arcs *b* in the cutter which is to produce the punch. This is very easily done, as indicated in Fig. 6, the straight sides of the cutter being carried back truly tangent with the circle at *c c*, as this is important in the subsequent operation.

In the operation of making the final cutter, the blank is mounted in the milling-machine vise—again at the angle of 7 degrees, as shown in Fig. 7—the male cutter, of which the making has just been described, being mounted in the arbor. The milling machine is manipulated until the edge of the cutter contacts with the edge of the blank at *d*. The distance *e* by which the cutting edge is to stand from the edge of the blank being selected, it remains only to add this distance to twice the radius *b* in order to have the total distance $b+b+e$ by which the blank is to be moved sidewise by the cross-feed screw of the milling machine. To facilitate this the measurements given on the drawings are in all cases decimal and the required distance is easily obtained by the index dial.

It will of course be understood that the actual cutter is first blocked out roughly to the required shape in order to save time with the fly cutter.

Similarly, by making contact as shown in Fig. 7 at *f* and setting the index dial to zero, a starting point is obtained from which to determine the upward movement of the blank by an amount equal to the radius of the desired arc.

Since the two arcs *b*, Fig. 2, have the same radius, it is only necessary to feed the work lengthwise of the arbor by an amount equal to the distance *g*, Fig. 2, in order correctly to locate the cutter to produce the right-hand arc of Fig. 7.

Two arcs of the final cutter are now complete and it remains to obtain the arc whose radius is *h*, Fig. 2. The method of producing this arc does not differ essentially from the one described, except that the radius being much larger and only a short part of the complete semicircle being used, the initial piece of tool steel is mounted on a lathe face plate and the arc is produced by a boring tool. A male cutter is made from it as in the former case, particular care being taken that the center of the arc is in the center of the piece. In milling the final cutter the elementary cutter is located horizontally by first contacting with the edge of the blank, as at *i*, Fig. 8, and then find-

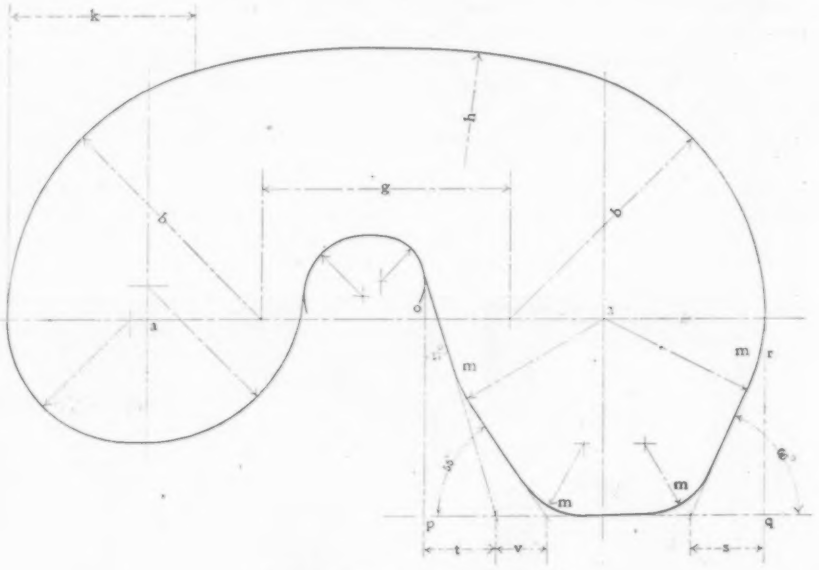


FIG. 2. OUTLINE OF THE LINK

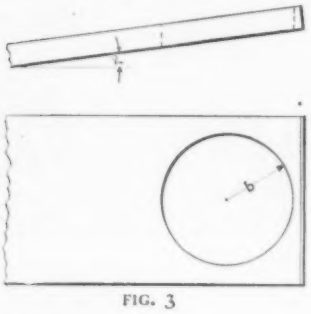


FIG. 3

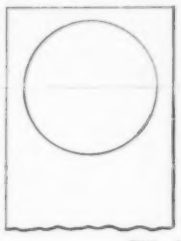


FIG. 4

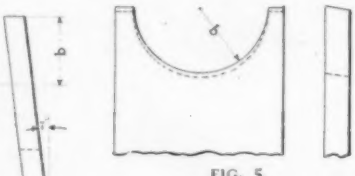


FIG. 5

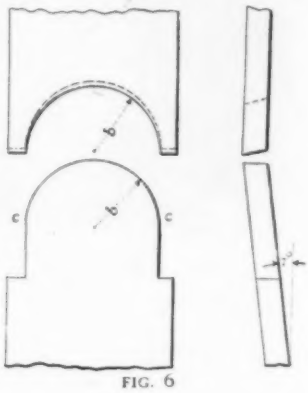


FIG. 6

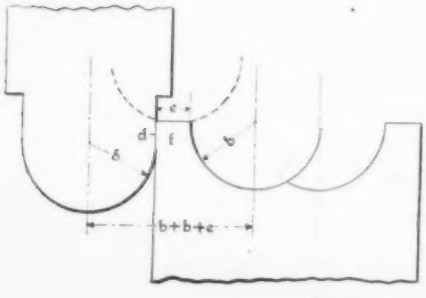


FIG. 7

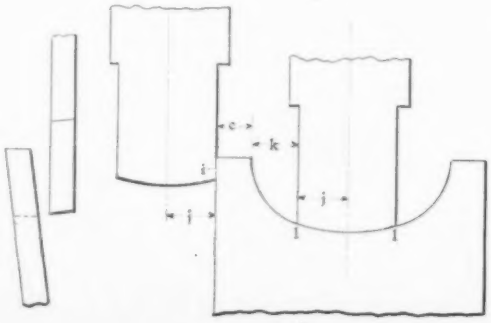


FIG. 8

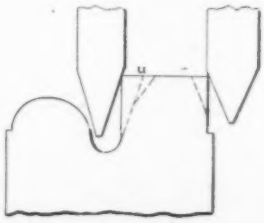


FIG. 10

MAKING THE CUTTERS

ing the sum of $j + j + e + k$, k being taken from the drawing, Fig. 2. The vertical movement is obtained by feeding the blank upward until the junctions at l and l are just wiped out.

The final punch and die are shown at the right in Fig. 9, and at the left is the complete set of cutters from which the outer half of the profile was obtained, except that in this case the arc h of Fig. 2 is replaced by a straight line. The complete cutter of Fig. 8 is shown at a, the male cutter by which it was made at b and the original female cutter at c.

The making of the cutter for the lower half of the punch involves an additional transfer process in order to produce the rounded corners in Fig. 2. And on this account the elementary cutters are used to produce a complete male cutter of which the final female cutter is a reproduction.

Looking at the final complete cutter h at the bottom of Fig. 9, it is clear that the right-hand gap could not be produced by straight elementary cutters without destroying these rounded corners, whereas looking at the cutter immediately above it, it is clear that these straight sides can be so produced, the rounded

FIG. 11. A COLLECTION OF FLY CUTTERS

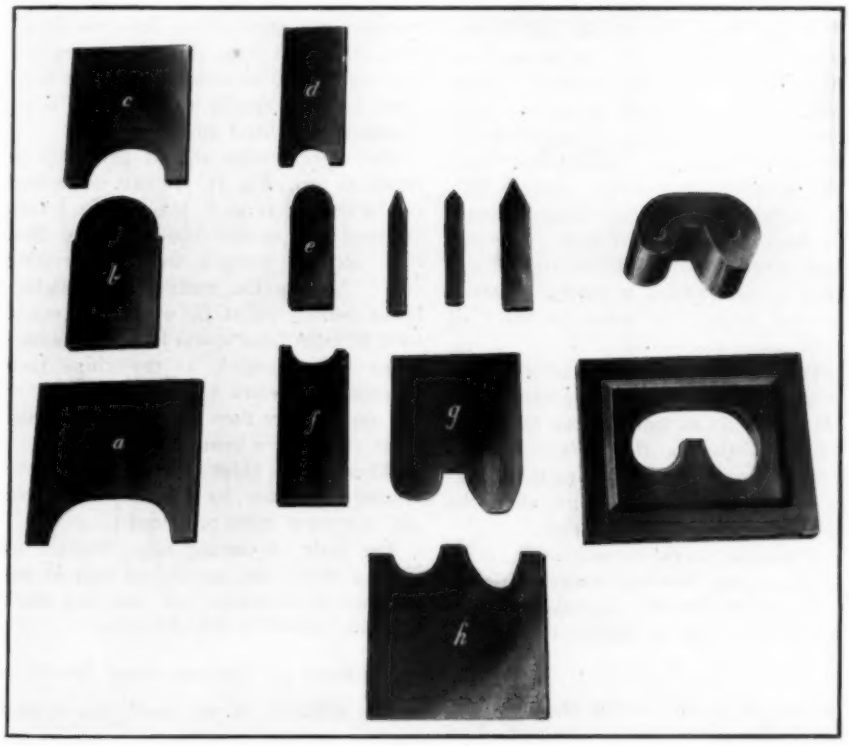


FIG. 9. THE PUNCH AND DIE AND THE COMPLETE SET OF FLY CUTTERS FOR MAKING THE PUNCH

corners being made by a subsequent operation. It is obvious, however, that the left-hand gap may be produced by a method which does not differ essentially from that already described. It will be seen from Fig. 2 that this gap involves two arcs of different radii and these in turn involve two elementary cutters and two sets of transfer cutters, although but one elementary cutter d and one set of transfer cutters $e f$ are shown in Fig. 9. The original cutter is shown at d, and from it e was made, one side of f being made from e while the other side was produced from a pair of cutters similar to e and f but of different radii. With this exception the production of cutter f does not differ from that of cutter a. With cutter f in hand, it is clear that the left-hand portion of cutter g may be readily made, and it only remains to show how the right-hand part is produced. This part is first blocked out, as shown by the full lines of Fig. 10, this blocking out being carefully done so that the outline accurately represents that shown by the lines $o p q r$ of Fig. 2. Elementary cutters ground to the angles shown in Fig. 2 are then mounted one at a time in the milling-machine arbor as indicated in Fig. 10. The machine being then put in motion, the blank is carefully fed horizontally until the cutter just nips the corner of the blank as shown in Fig. 10, when the dimensions $s t$ respectively of Fig. 2 show the additional amount of feed necessary to cut the stock to the dotted lines. These operations complete, a third angular cutter is used in the same way, first nipping the blank at u, Fig. 10, after which a feed of the blank equal to a distance v, of Fig. 2, completes the outline so far as the angles are concerned, the rounded corners being subsequently made by additional cutters which it is not necessary to show.

It has been explained that the distortion of the circular arcs into elliptical arcs due to the inclination of the cutter blanks in the milling machine is not important; but in the case of these angular cuts, since they make those portions of the links which engage with the sprocket teeth, no such distortion is permissible. To provide for this the angles of the elementary cutters are carefully calculated and ground to compensate for the inclination of the blanks and give exactly the angles required in the finished work.

Cutter g of Fig. 9 being produced, it is of course a simple matter to produce cutter h from this, and with cutters a and h complete the production of the punch is a simple matter. The die of Fig. 9 is first roughed out to the desired outline by drilling and filing, the final shape being produced by the use of the punch as a broach, a little hand grinding after the cutter is hardened compensating for the shrinkage due to hardening.

As a matter of interest, Fig. 11 is added, showing the extent to which these methods are followed, the cutters shown being, however, but a few of those in actual use.

F. A. H.

Collapsible tubes, in which paste, cosmetics, glue and other materials are sold, are made of pure tin. It has been found impossible to use a compound sheet of tin and lead as it will not stand the operations of the press.—*The Brass World.*

Why Chips Cling to Screw-machine Tools

Showing How Improper Clearance and Rake, Excessive Speeds, Etc., Cause the Chips to Heat and Weld to the Cutting Edges of Tools

BY C. L. GOODRICH*

Clinging of chips to the cutting edges of tools used in the screw machine or under similar conditions is due largely to the heating of the chip or of the cutting edge of the tool, or both, to such an extent as to cause the chip to become "welded" to the tool.

This heating may be caused by: (1) Lack of sufficient angular clearance between tool and work; (2) too high cutting speed and consequent dulling of cutting edge of tool; (3) insufficient and improper cooling or lubricating material; (4) incorrect rake of cutting edge of tool; (5) lack of chip room; (6) too much non-cutting tool surface in contact with work.

Clearance

Referring to the matter of angular clearance, Fig. 1 gives an idea of desirable conditions for a cutting-off tool, while Fig. 2 illustrates undesirable conditions. The slight flat at *a*, Fig. 1, is to insure smoothness to the work. In case circular tools are used in the ordinary manner to cut down a form, as in Fig. 3, there is no clearance at the outer edge of the cutter at *b*. By swinging the center slightly, as shown in Fig. 4, so that the axis of the cutter is not parallel with the axis of the material being worked, perfect clearance may be obtained. When one tool is used for cutting both sides of a narrow slot, as in Fig. 5, a rectangular form of tool is generally recommended, as complete clearance can be obtained. This form of tool has a relatively short life as compared with the circular type of tool, and consequently the latter with its partial clearance, as shown in Fig. 6, is commonly used. In cases where it is not subjected to severe duty as regards cutting speed, fairly good results are obtained. When the width of the slot is not important, each side of the tool may be finished spirally, giving excellent clearance conditions, as illustrated by Fig. 7. The clearance should be ample to avoid undue contact with the work, but on the other hand not be so much as to produce a thin cutting edge, as the latter will quickly heat under working conditions and then, becoming soft, will rapidly become unfit for use. Furthermore, chattering may result from too much clearance, as indicated at *A*, Fig 10.

It should be obvious that internal cutting tools require clearance as well as external tools; in the former case not only the cutting lip, but the outer diameters require back clearance, as represented in Fig. 8.

Cutting Speeds

It is conceded that there is a limit to the cutting speed on account of the edge of the tool giving out when an exceedingly high speed is attempted. There is also a limit due to the heating of the chip so as to cause it to weld to the tool. Apparently the material being worked has considerable to do with this trouble; my experience is that soft low-carbon steel and brass and similar materials will cause the most trouble, as the welding process occurs before a speed destructive to the cutting edge has been reached. On harder material, i.e., cast iron or steel with more carbon, the welding is not as troublesome.

Cooling and Lubricating Materials

In many shops "good lard oil" is the standard prescription for use in connection with external and internal cutting operations on cylindrical work. I fully appreciate the advantages of oil when the element of friction plays an important part —for instance, in cutting threads with dies or taps, and in some other internal cuts—but have repeatedly seen successful results when absolute failure seemed apparent by substituting a cooling material composed largely of water in place of the oil.

Oil positively will not conduct away the heat generated by high cutting speeds and feeds as rapidly as many of the numerous cooling materials on the market. Oil, as compared with the thinner liquids, is sluggish in penetrating to the point where the chip is being torn from the work.

For internal work a compromise, or in some cases the clear oil, is more desirable on account of the fact that the tools do not generally have as perfect a clearance.

Rake

In case of the tool having negative rake, as at *C*, Fig. 9, the chip will be pushed off instead of being clean cut and curled, as at *D*. When negative rake is carried to extremes, the chip which is being broken off may be drawn between the cutting edge of the tool and the work and thus become wedged and heated, and welding may result. The wedging action is particularly troublesome on internal work and may frequently be overcome by changing the type of the flute in the tool.

In cases of tools having excess positive rake, as in Fig. 10, the cutting edge, being so thin, rapidly heats and becomes destroyed, so that this condition must also be avoided.

Clearance and rake form quite a deep subject. The exact amount depends upon the nature of cut as well as upon the nature of the material being cut; in this article it is not desirable to go into the matter at any great length. The point to be emphasized in connection with the subject being treated is that the cutting edge must not be given too acute an angle.

Chip Room

On internal cutting tools, when there is little chip space, the packing or wedging of chips and the resulting heat cause much trouble, particularly on brass and similar materials; increased chip space overcomes the difficulty.

The form of cutting flute influences greatly the welding action, and in some instances the spiral of the flute has an effect. Where a long chip causes trouble, a straight flute or sometimes a left-hand spiral is more satisfactory than the more common right-hand spiral.

The cutting edge should generally be radial, as at *E*, Fig. 11. In case it is ahead of the center, as at *F*, the chip is forced outward and against the work and then may become wedged into the cutting edge. Making the cutting edge slightly below center, as at *G*, where a straight flute or right-hand spiral is used, is sometimes recommended, as the chips then automatically work toward the center of the tool and are then forced out from the front of the hole being bored.

When wide chips cause trouble, the cutting edge may be serrated or broken and narrower chips produced.

The style of cutting edge, number of cutting edges, etc., are second only in importance to clearance and rake, and much is to be learned in this direction.

Surface in Contact with Work

The difficulty of too much non-cutting surface in contact with the work is experienced mostly with internal cutting tools and particularly in brass and bronze work. *H*, Fig. 12, illustrates a drill correctly relieved; *K*, Fig. 12, is bad. In the latter case the material being worked becomes welded to the surface *L*, on account of the heat caused by the rubbing action of such a great amount of contacting surface.

In conclusion, while it is generally the practice to design tools to suit the material, it must not be overlooked that a slight change in the nature of the material

*Department foreman, Pratt & Whitney Company, Hartford, Conn.

being machined will oftentimes make possible great improvement both as to quality and quantity of work turned out.

Sometimes the accusation of crooked threads is lodged against pipe-fittings, when in fact the trouble is that the threads on the pipe are crooked. The fault may readily be correctly located, in a case where a pipe screwed into a fitting is out of line, by giving the pipe a half-turn. If the alinement of the pipe remains unaltered, it is the threads of the fitting which are out; but if the half-turn causes the pipe to slant the other way, the trouble is with the threads on the pipe itself. The *Valve World* states that crooked threads on pipe are usually threads that are cut by dies in stocks, and are caused by the fact that the distance between the die and bushing is too short. In cases where the bushing is badly worn, the die is quite as apt to cut a crooked thread as a straight one, as the bushing does not keep the die in alinement with the pipe.

It is stated that the Indian Government has decided to set apart a sum of £5000 for development experiments in India in connection with the mono-rail system.

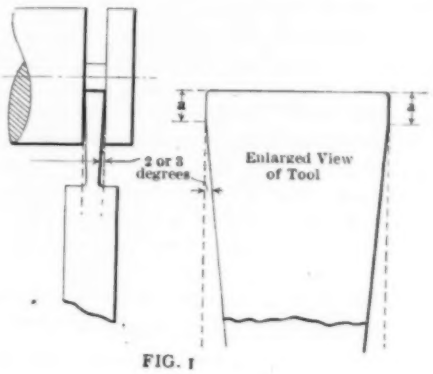


FIG. 1

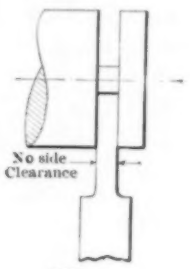


FIG. 2

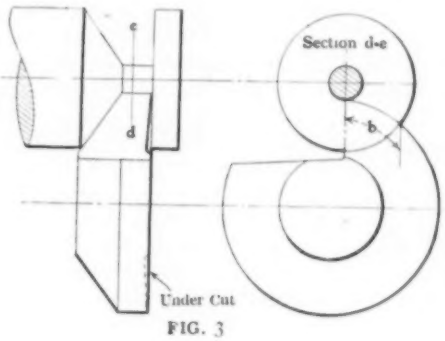


FIG. 3

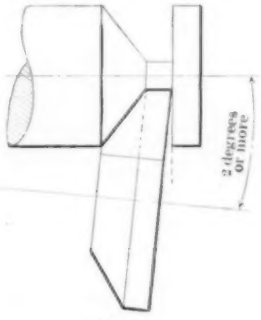


FIG. 4

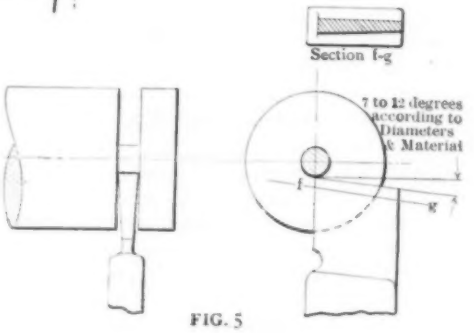


FIG. 5

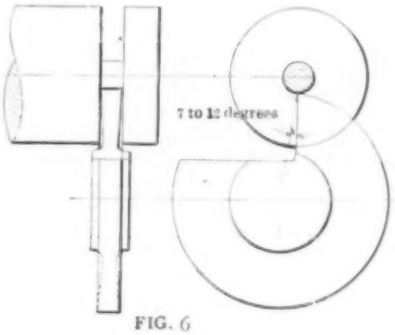


FIG. 6

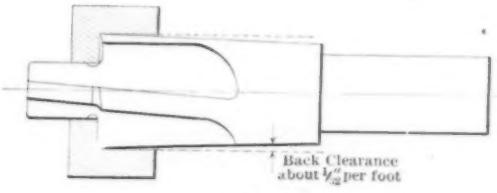


FIG. 8

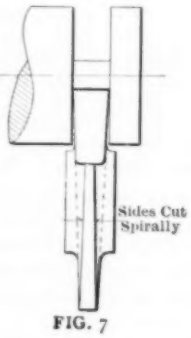


FIG. 7

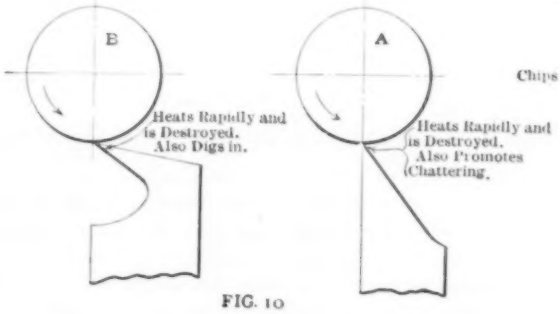


FIG. 10

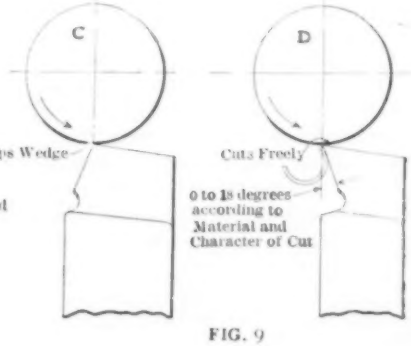


FIG. 9

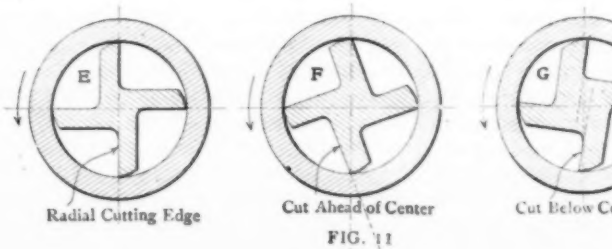


FIG. 11

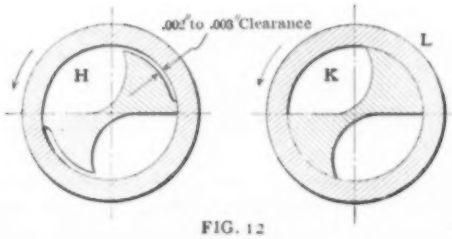


FIG. 12

SHOWING CUTTING ACTION OF VARIOUS TYPES OF SCREW MACHINE TOOLS

Types of Automobile Steering Mechanisms

Their Comparative Merits for Various Kinds of Service, and the Principles Controlling Their Design and Laying Out

BY E. J. BARTLETT

Some interesting problems pertaining to the design, construction and operation of the modern automobile are found in the various steering mechanisms employed. Like almost every other important mechanical feature the steering devices now in general use have resulted from a careful study of the conditions to be fulfilled, supplemented by extensive experiments with different types. With a few exceptions of no great commercial importance as yet, such as the rear wheel steering or four-wheel steering machines, these researches have resulted in a general steering system which is applied in different forms to all standard automobile châssis, regardless of the service which they perform. This in brief consists of a hand wheel or lever connected through some form of linkage or gearing leverage to the front wheels of the vehicle; these wheels being carried on pivoted ends of the front axle. The design and construction of some of the most important features of this general arrangement afford interesting subjects for discussion.

The Limits to the Swing of the Front Wheels

Since the operation of an automobile within a limited space, such as a narrow street, is generally of importance, the extreme throw of the front wheels from side to side is one of the first points to be settled upon, as the amount of this throw, together with the wheel base and wheel gage, determines the turning radius. In practice the wheel base and gage are roughly established by the load or body requirements, and with these fixed, the throw of the front wheels is usually limited, on one hand, by the width of the body, frame, or springs, and on the other by the permissible distance between the pivot centers about which the wheels swing. Even if conditions permit it is never best to make the extreme throw of the inner wheel from the straight-ahead position over 35 degrees, as the angles the connecting rods make with the pivot levers become too acute or obtuse, according to their location, to permit of easy or even safe operation. An average throw is perhaps 30 degrees, to which figure the diagram shown in Fig. 1 is laid out.

Avoiding Side Slip on the Tires When Rounding Curves

It is evident that the theoretical center about which the vehicle turns is somewhere in the center line of the rear axle prolonged, its exact location being determined by the intersection of this line by a line drawn normal to the inside front wheel. Another line drawn from this point to the center of the outside front wheel and normal to it determines the angle at which this wheel must turn to prevent an excessive side slip, which is very destructive to the rubber tire. The four wheels will then describe concentric circles about the turning point as indicated by the dotted arcs in Fig. 1, the differential gear or equivalent device allowing the proper relation of speed between the rear wheels. As the outer front wheel pivot is turned a less angle than the inner, and yet is connected, by means of a cross rod, rigidly to it, there must be some compensating device interposed to give the same angular relation when the wheels are turned in the opposite direction. This is accomplished by making use of the principle of varying ratios of sines of the angles at different points in the arcs through which the pivot levers turn as shown in Fig. 2. This necessitates locating the pivot levers so that their center lines diverge if they project ahead of the axle and converge if they project back of it. Then, as the wheels swing, the pivot lever mounted on the bearing of the inner wheel travels away from the dead center point in its arc, while the outer wheel pivot lever is moving toward and by the corresponding point in its arc, thus traveling a less angular distance. Any single location of the pivot levers can be absolutely correct for one position only of the wheels. In Fig. 1 this position is shown at the extreme throw or 30 degrees, which is not unusual in practice, as the slipping tendency of the tires is greatest when the wheels are turned through a large angle. The approximately correct angles for the other positions of the wheels are correct enough for all practical purposes.

Fixing the Lever Angles

The writer has never seen a mathematical demonstration for locating these levers for a given set of conditions, although various approximate formulas are sometimes used. In practice these angles are usually determined graphically by cutting and trying until the proper results are obtained. This is easily done after the angle of the outer wheel is calculated on the basis of the angle of the inner wheel. In the conditions shown the outer wheel angle is in round numbers 24¾ degrees against 30 degrees for the inner wheel.

Location of the Pivot Levers—The Relative Merits of Front and Rear Location

Having determined the angle at which the pivot levers are to be set, the next step is to decide upon their location in reference to the front axle. Practice is about equally divided between mounting the levers so as to project in front of the axle, as shown by the full lines in Fig. 2, or back of the axle indicated by the dotted lines, although the former location is preferable where it is possible, for several reasons. Since the front axle is pushed by means of the springs attached to it and to the body, the tendency of the wheels is to swing outward, putting the rod connecting the pivot levers in tension, if in front of the axle, as it should be for small continuous strains, and in compression, if in the rear, which is not so rigid a construction if the rod is long and slender. Moreover, the majority of the heavy road

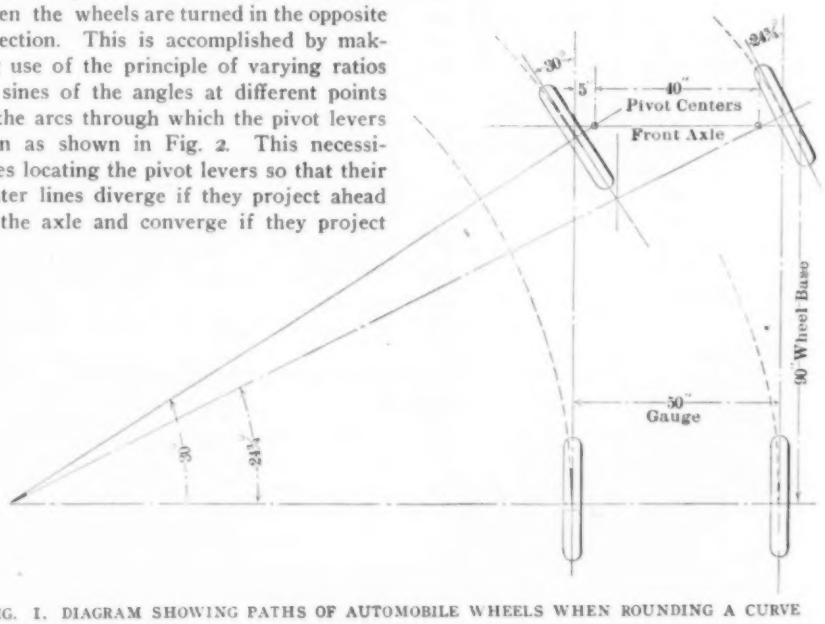


FIG. 1. DIAGRAM SHOWING PATHS OF AUTOMOBILE WHEELS WHEN ROUNDING A CURVE

shocks are taken on the wheels from the front and outside, as when the car strikes the street curbing a glancing blow. This suddenly throws one wheel in and if the rod is in front, it will buckle momentarily while transmitting the blow to the opposite wheel. If this rod is slender, as it usually is, it will spring back to its normal straight position, but if the rod is in the rear of the axle the same blow puts it in tension and, if the shock is severe enough, rupture may result in the rod itself or its ends connecting to the pivot levers.

On the other hand, the proximity of the wheel spokes to the pivot centers, a desirable feature in itself, may not allow a proper divergence of the pivot levers if in front of the axle, or the cross rod may possibly interfere with the engine-starting crank or other detail of the car. In such cases the levers are caused to project back of the axle and are entirely satisfactory, as the objections to this location are not serious when the parts are well and strongly made.

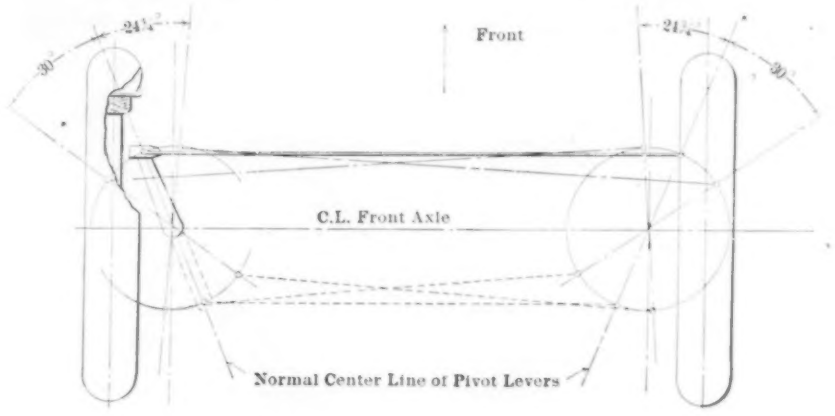


FIG. 2. LOCATION AND ACTION OF PIVOT LEVERS

The Inclination of the Axes of the Pivots

If the pivots rotated in simple vertical bearings, the stresses on the connecting rods from the causes mentioned would be more severe than they are in practice; for, with the pivots properly mounted, the shocks are absorbed to quite an extent and not transmitted to the more fragile connecting and steering mechanisms. In the most approved construction the pivots are inclined some 3 degrees or so, the lower end forward. The ordinary road shocks affecting both wheels occur at or near the ground-contact point and are for the greater part transmitted radially to the pivots, tending to wrench them from their sockets or supports; a small component only of the blows tending to turn the wheels on their bearings. This being so, the inclined pivot supports strengthen the construction, as the shocks are partially absorbed in the effort to straighten up the pivots in their supports. The bearing spindles are also set by arching the axle at the center, or in the pivot construction to counteract the dish given the wheel spokes, so that the vertical spoke between the contact point on the ground and the wheel hub is in direct compression. The pivot bearings are also inclined in the plane of the axle so that their center lines prolonged intersect the ground in line with the points of wheel contact, but a little ahead of them, owing to the inclination of the pivots.

A Certain Degree of Self-steering Attained

This construction also assists the wheels in finding the paths of least resistance among the small road obstructions, as the tendency of the wheels is to return without effort of the operator, to the straight-ahead position when momentarily diverted. The set of the bearings also keeps the thrust of the wheels at the same places all the time, and prevents the lateral movement which would occur if considerable clearance developed through wear and the bearings were horizontal.

In practice all these theoretical conditions are seldom if ever fulfilled exactly, as reasonable approximations are entirely satisfactory. The conditions to be attained as mentioned above are shown in Fig. 3, where the angles are exaggerated to show them more clearly.

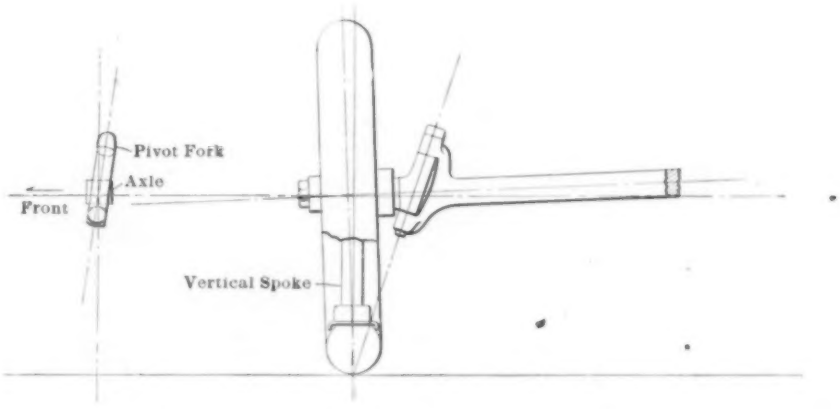


FIG. 3. SHOWING ANGLE OF PIVOT MOUNTING, EXAGGERATED

The Question of Reversibility of Steering Gears

Before proceeding with a discussion of the different types of steering gears in actual use it is well to consider the degree of reversibility it is best to attain under different conditions, and why it is advantageous—that is, to what an extent the steering function of the pivoted front wheels should be affected by the road obstacles encountered. In this connection three factors are to be considered: these are, the operator, the speed and weight of the vehicle, and the surface of the road.

Reversible Gearing

With a perfectly reversible gearing system it is evident that the road shocks which are transmitted to the operator depend only on their magnitude and the leverage through which they act, neglecting friction of the moving parts. Such a system is therefore best adapted for light, slow-speed vehicles running over smooth roads. Examples of such a type are the light electric carriages in common use.

Semi-reversible Gearing

Between the limits of the reversible and irreversible gearing systems is the semi-reversible which by the proper design of the worm and sector or screw and nut gears allows the vehicle wheels to be turned independently of any effort exerted on the steering wheel, yet exerting an even resistance to the movement. This feature allows the wheels to follow the paths of least resistance and at the same time indicates to the operator the extent and direction of the movement by a more or less extensive swerve of the steering wheel, depending on the gearing ratio. As previously explained there is by proper pivot mounting a tendency for the wheels to correct any slight deflections. This tendency is also aided by the gyroscopic action of the wheels, and the springs used in the spring buffer connections to be mentioned later. The amount of deflection of the wheels which is automatically corrected is usually about the same as the back-lash in the steering system due to

the joints in the system, and the compression of the buffer springs, so that slight deflections of the wheels in a semi-reversible system are not noticed by the operator. Beyond this point he follows up and corrects the movement of the steering wheel, operated reversely by the vehicle wheels swerving, with much less fatigue than would be possible if the system were entirely irreversible and every slight necessary movement involved action on his part. The semi-reversible system also relieves the parts of considerable strain which would be present if the vehicle wheels were rigidly held up to their position.

Another point which is perhaps worthy of consideration is the handling of the car when in storage. It is convenient though of course not necessary that the car can be operated from the floor by swinging the wheels and pushing it into place when the car is not under its own power. It frequently prevents dirt and oil being brought into the car by the operator's hands and feet if the wheels can be turned by hand and also less help and time are required in the operation of moving the car.

Sometimes Semi-reversibility is not Desirable

A disadvantage of the semi-reversible feature is in steering through sandy or muddy roads and in crossing obstructions such as car tracks obliquely.

Irreversible Gears

Heavy-service vehicles seem to offer a logical field for the irreversible gear as the connection may be made heavy and strong. The tires are also hard, often of wood or steel, and the range of service is frequently restricted largely to streets paved with cobble stones. Considerable backing and turning over car tracks may be necessary, all of which tends to make the irreversible gear a favorite by relieving the operator of jerks and considerable mucular exertion on the steering wheel. Also it admits of a very low gear ratio or large hand-wheel motion which is desirable from the leverage standpoint in operating a heavy vehicle when at a standstill or moving very slowly. These considerations insure the use of the irreversible gear to quite an extent for heavy service, and some designers prefer it for lighter work. The semi-reversible system, however, which offers a reasonable amount of resistance from the wheels is much more widely used and seems best adapted to ordinary medium- and high-speed requirements.

Steering-gear Ratios

Closely related to the question of reversibility is that of gear ratio. Since the ratio of the whole system is brought about by means of levers, such as the pivot lever and steering arm operated directly by the steering gear proper, as well as by the gear itself, it may vary somewhat independently of the action of the steering gear although considering the gear alone its degree of reversibility determines the gearing ratio. That is, a worm or screw of fairly high lead in the steering gear is semi-reversible and in itself predetermines a high gearing ratio—a small turn of the steering wheel for a considerable turn of the vehicle wheels; and a low lead worm or screw is irreversible, it has a low gear ratio—a large turn of the steering wheel for a small turn of the vehicle wheels; but the relative lengths of the levers between the gear and the wheels may be such as to obscure, to a certain extent, the action of the entire system.

For a vehicle which travels at considerable speed a fairly high gear ratio is doubtless almost a necessity for easy operation, since it allows turns to be made with less manipulation of the steering wheel. Also since high gearing for the operator means low gearing in the reverse direction, with a semi-reversible gear, the sudden swerving of the wheels due to the road obstruction moves the steering wheel less and hence the operator is less liable to have it jerked from his hands and for the instant lose control of his car.

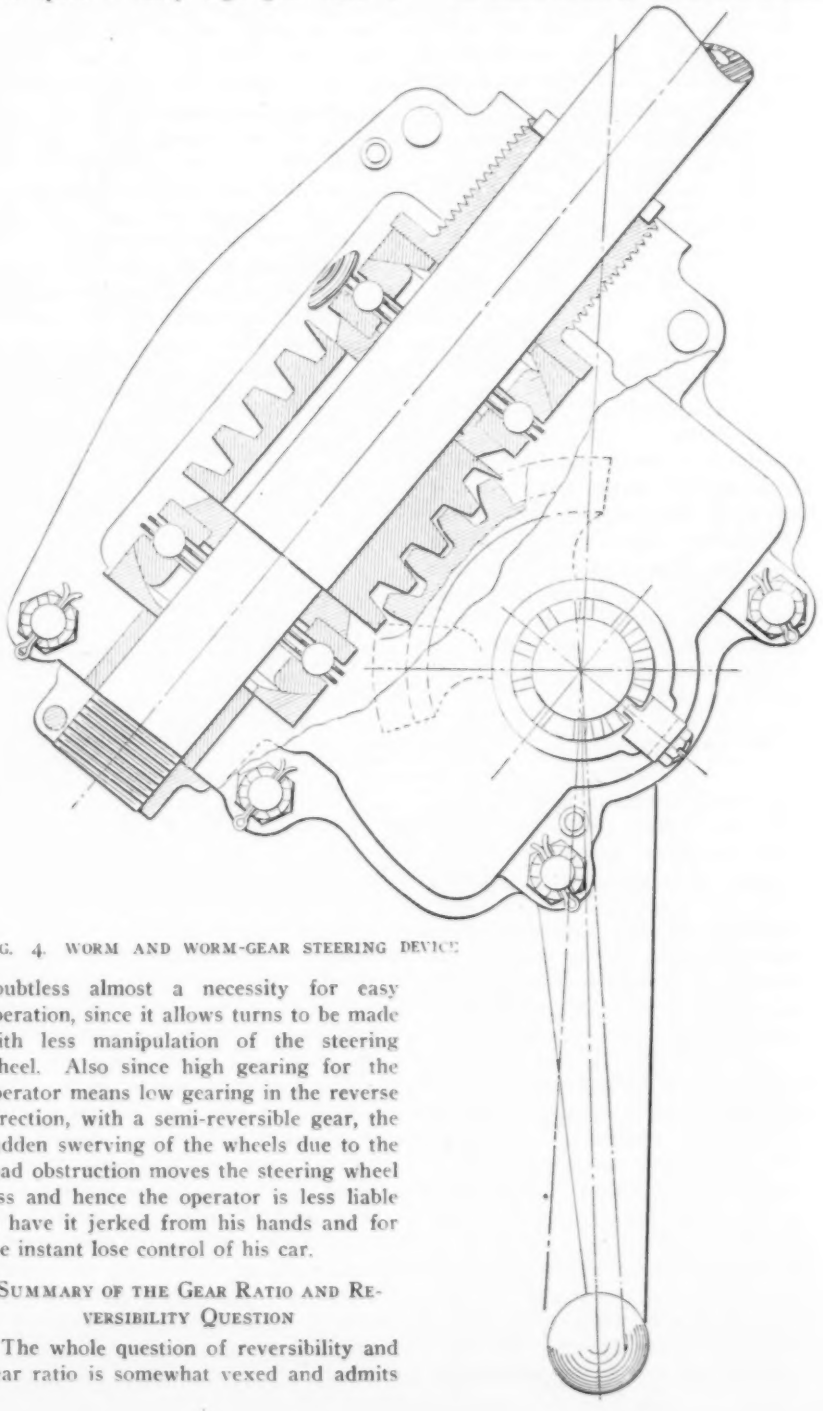


FIG. 4. WORM AND WORM-GEAR STEERING DEVICE

Summary of the Gear Ratio and Reversibility Question

The whole question of reversibility and gear ratio is somewhat vexed and admits of many solutions by making different combinations whose suitability depends to quite an extent on the individual inclination of every operator. A lengthy discussion could be written on the subject but perhaps the important points have been sufficiently touched upon. A brief summary which perhaps represents average practice outside of cars employing a lever steering system is as follows:

A medium-high gear ratio and reversibility for light, slow-speed vehicles designed for pleasure service.

A medium-high gear ratio and semi-reversibility for all other classes of pleasure vehicles.

A low gear ratio and irreversibility for heavy and slow-speed commercial service.

The limits of the gear ratios as ordinar-

ily applied are from one to two turns of the steering wheel for a full throw of the vehicle wheels, intermediate amounts between the extremes being used on the majority of cars.

Lever Steer

Considering the various steering systems more in detail the lever steer is the oldest and simplest. As commonly used it consists of a vertical post carrying on the upper end a long lever operated by the driver and on the lower end a shorter lever connecting directly to an extension on one of the pivots or pivot levers. It is, of course, entirely reversible and necessarily of high gear ratio. A short hand lever means a reduction in leverage while a long lever gives an excessive movement of the hand and is jerky to control, which further explains its limitations already mentioned.

Worm and Worm-gear Devices

The majority of cars, particularly of the pleasure type, are equipped with a worm and worm sector, the worm being mounted on the lower end of the steering post or column and the sector on a shaft carrying on one end a lever connecting to one of the wheel pivots. Such a gearing device, when in good working order, is semi-reversible to a degree depending upon the lead to which the worm and sector are cut, and may be made correspondingly fast or slow in its movement.

The Drawback of Uneven Wear

The principal objection against the worm-gear steering device is the difficulty in satisfactorily adjusting it for the wear, which is uneven, as the almost continuous small movement of the wheels sidewise when the car is running approximately straight ahead causes the worm and sector teeth to wear uneven. Considerable looseness may develop which may be dangerous, if excessive. Adjustment is usually provided by mounting the sector shaft in eccentric bushings, as shown in Fig. 4, but if, by means of these bushings, the sector is brought into closer engagement with the worm in the straight-ahead position, the teeth will bind at the extreme throws where the wear is slight.

For this reason some designers provide no adjustment whatever, depending upon large diameters, wear-resisting materials, and specially increased wearing surfaces, such as a worm the ends of which are larger in diameter than the center, thus allowing more threads in engagement.

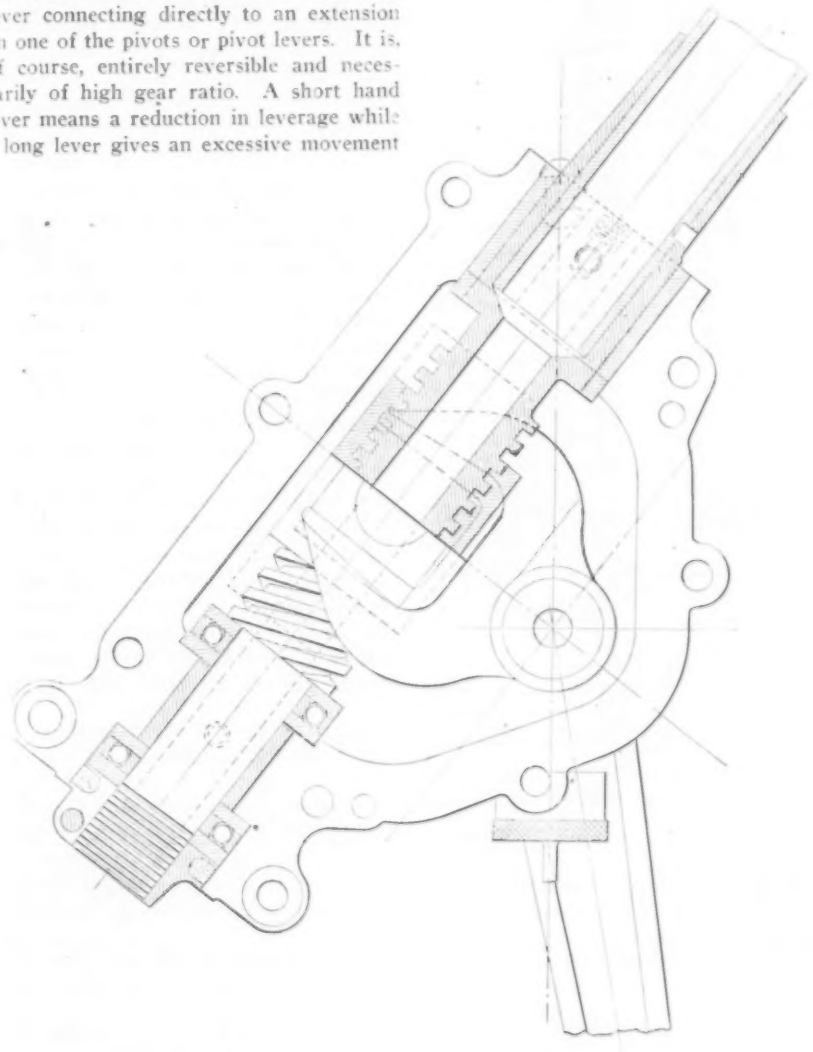


FIG. 5. SCREW AND NUT STEERING DEVICE

Another device sometimes resorted to is where the sector is carried in rectangular guides. It may then be withdrawn from mesh, and the worm turned so as to bring an unworn portion in engagement when the sector is meshed again.

Still another arrangement is where a complete worm-gear, rather than sector, is employed so that different points may be meshed with the worm as they wear loose. This construction is liable to be heavy and clumsy, however, unless a gear of small diameter is used, entailing a corresponding loss of leverage and a high tooth pressure.

Lubrication is an important factor also, as a gear which is semi-reversible when the case is filled with lubricant may become irreversible when it runs dry, and may even become difficult to operate.

A Typical Worm Steering Gear

The device illustrated is, perhaps, a typical gear of this type. The worm is quadruple-threaded, ½-inch pitch, 2-inch lead, and made of hardened steel. The sector is also of hardened steel, although a hardened-steel worm and bronze sector is a favorite choice of materials.

Screw-and-nut Steering Gears

Fig. 5 illustrates a screw-and-nut steering gear. The reversibility of a screw and nut of equal lead is very nearly the same as that of a worm and sector, but a high lead which would be safe with the latter would be liable to stick with the former construction owing to the increased friction and difficulty of lubrication which is the principal objection to this type of steering gear. For this reason the screw-and-nut construction in practice is usually semi-reversible to a less degree than the worm and sector. Its advantage over the worm and sector is its increased bearing surface, and the even distribution of wear, making it unnecessary, if the proper materials and sizes are used, to provide any adjustment whatever. This is an important feature, as satisfactory adjustment is even more difficult than in the worm-and-sector type.

Arrangements for Taking Up Wear

If the nut is split laterally and clamped together, as is sometimes done, the looseness is taken up, but the effect will be of short duration, as the wear is localized and the uniform bearing, which is the feature of the whole device, is destroyed. Much the same results may be expected if the nut is split longitudinally and clamped together as looseness develops, the wear being localized, though to a less extent, but the adjustment is less easily effected. It would seem that entirely efficient adjustment can be best obtained by the use of two nuts, right- and left-hand threaded, and a double screw. Even with this arrangement the construction must be such that the units operate under pressure in one direction only, thus bringing

the wear on one side of the thread and allowing the screw to be adjusted to take up any looseness which might develop. Such arrangements are in use, though to a limited extent. A design of this type is shown in Fig. 6.

Various modifications of the design shown in Fig. 5 are made, dealing principally with the method of holding the nut from turning. In some cases the fork holding the nut on trunnions, as shown, is omitted, and the nut is guided by finished surfaces on the case itself, while in other designs the nut is held by trunnions which slide in grooves in the case.

Materials Used

Several different combinations of materials are used. A cast shell, babbitt lined, with a steel screw, is a common choice, although bronze and steel or steel and steel, with generous bearing surfaces, are sometimes used with much success.

The screw-and-nut or double-screw-and-nut gears are nearly if not always employed where irreversibility is desired.

The device shown in Fig. 5, which is typical of its class, has a screw with quadruple thread, 5/16-inch pitch, 1¼-inch lead.

Special Devices

Under the head of steering devices, which are used to a less extent than those mentioned above, may be noted some recent applications of the planetary system of gearing. These gears are inclosed and carried under the steering wheel, the steering post being divided to allow the relative speed motions, thus protecting them from dirt. The wear is small and the parts easy and inexpensive to replace, as the wearing surface is increased owing to the number, usually three, of intermediate pinions in the system and the cheapness of manufacture.

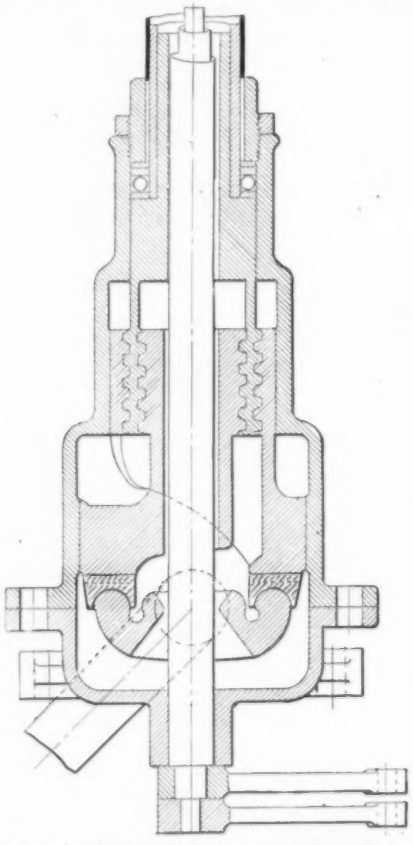


FIG. 6. DOUBLE SCREW AND NUT STEERING GEAR

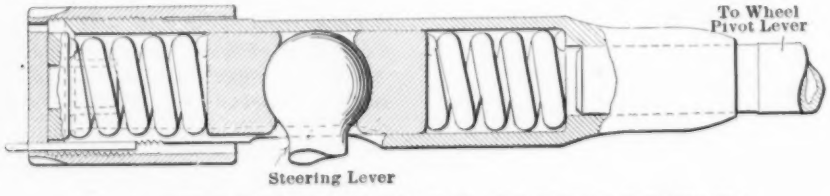


FIG. 7. BUFFER SPRING CONSTRUCTION IN FORE-AND-AFT STEERING ROD

A bevel pinion and gear are sometimes used. The action is, of course, the same as with a plain spur gearing, but it is a convenient method of changing the direction of motion.

Rolls operating in grooves in cam plates in connection with linkage arrangements have been used to a limited extent, but are by no means common.

A modification of the simple spur gearing is sometimes seen where a skew pinion meshes with a rack mounted at such an angle as to be slightly semi-reversible in its action.

The plain spur-pinion meshing with a sector and small sprockets driving by chain, where the steering and intermediate posts are some little way apart, are of course often used for slow-speed service where considerable leverage is required. Probably a few other devices or modifications of those noted are sometimes used, but, judging from the cars seen at such gatherings as the automobile shows, the worm-and-sector gearing is employed on the majority of cars, with the screw-and-nut a close second. Indeed, the latter seems to be gaining in popularity chiefly owing to its uniform wearing qualities, the single screw and nut leading over the double.

Connecting Rods

One other factor of the steering system should be mentioned—the rod connecting the pivot levers together and that joining one pivot lever to the steering arm operated from the gear itself. These rods are usually made hollow for lightness, with forged ends of either the fork or ball-and-socket construction. It is well to have one end of the cross rod adjustable, so that the wheels may be kept properly lined up even if the rod or pivot levers become, through accident, bent slightly. The adjustable end, however, should be firmly clamped and safe-guarded against working loose. The fore-and-aft rod frequently has buffer springs in one or both ends, as shown in Fig. 7. These springs take some of the force of sudden shocks off the gears and operator. In a strictly irreversible gear, springs with a considerable scope of action are of advantage. Like the cross rod, this rod should be adjustable at one end and firmly secured.

Using a Try Square on Planer Work

By H. L. Cameron

To get the full value of a tool it must be used to the best advantage. To square an angle plate on a planer a very safe way is to clamp the square to the plate as shown in Fig. 1, then run the table back and forth and try a piece of paper between the tool and square blade. To hold the blade level for squaring the other way two blocks of wood *A A* of an even length may be used.

To set a piece of work square across the planer table the side of the table is first known to be true for the inside of the square base to rest against, the blade of the square must next rest flat upon the table so that the edge of the blade itself is square, for the sharp corners of the blade soon become worn round in *places*. To hold the square blade balanced flat on the table with one hand and try the contact with the other is sometimes very tiresome work, and it will be found a great relief to balance the square as shown in Fig. 2 which is simply a piece of wood with three nails in it, arranged so that the two pinch on the dog and the third is driven in to hold the square so the blade just lay flat. The dog is left loose that it may be slid along to any place where needed.

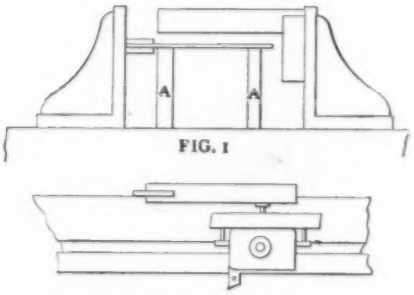


FIG. 1

FIG. 2. USING A TRY SQUARE ON PLANER WORK

Most machinists use pieces of paper to try the contact of the blade, but I think a better method is to use one piece of light finished casting and slide it from end to end of the blade until it *feels* the same all along; there is less chance of springing the blade that way.

Elimination of Friction in Ball Bearings

Importance of This Question in View of the Application of Such Bearings in Heavy Work; Sources of Friction Analyzed

BY J. F. SPRINGER

The elimination of friction from bearings in general is one of the most important topics that can engage the attention of the mechanical engineer. There are three main reasons for this: First, friction means abrasion of material, and the removal of material through abrasion is a very great disadvantage, inasmuch as it

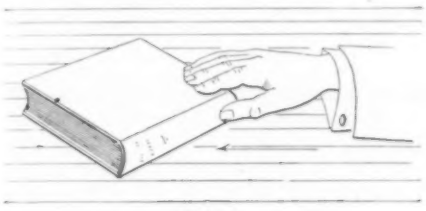


FIG. 1

results in change of form and dimensions of the contacting parts, thus limiting their life. This is what we term "wear and tear." Second, the wearing away of this material requires power, and this power is worse than lost. And in the third place, friction sets up heat, which alone is often a most serious detriment.

Friction is of two kinds—*sliding friction* and *rolling friction*. Given two surfaces in contact, if there is such motion of one relatively to the other that the motion is parallel to the contacting surfaces, the result is sliding friction. Thus, as in Fig. 1, a book pushed across the surface of a table gives an example of sliding friction. And, furthermore, it is immaterial whether the book is pushed in a "right" line. Indeed (Fig. 2), it may be rotated so that every point of the surface of the book contacting with the table surface, except the center of rotation, moves in a circle, yet sliding friction results if these circles are in a plane parallel to the surface of the table. Such friction arises, of course, because the contacting surfaces are not absolutely smooth and so present to each other irregularities which mutually engage. When motion occurs under pressure these mutually engaging projec-

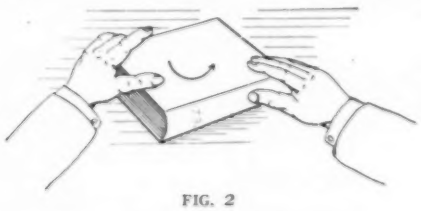


FIG. 2

tions tend to abrade each other (Fig. 3). This is because the pressure, in proportion to its amount, tends to maintain the interlock. As stated, the removal of the particles is wear, requires power and sets up heat. Thus is to be explained the excessive wear, loss of power and rise of temperature which occur in the ordinary plain bearing.

However, the motion may not be in a direction parallel to the contacting surfaces, but may be such that there is an introduction and withdrawal of small projections, and this constitutes a form of rolling friction. It is due to the fact that the contacting surfaces are not absolutely smooth, but present to each other slight protuberances and depressions at a time when contact is maintained under pressure (see Fig. 4), as is the case with a wheel. Then there is the continual presentation of limited contact, combined with pressure, whether that which rolls is a ball or a roller. If the particles in actual contact are not adequately supported by others in their vicinity, small particles are detached from both contacting surfaces by a crushing process. Hardness combined with toughness (which it is now possible to secure), goes far to eliminate this particular result of rolling friction. But the difference

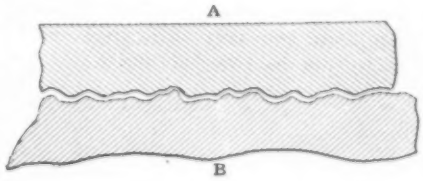


FIG. 3

between sliding and rolling friction, as to abrading result, is well known to be very great. Indeed, a mechanical engineer has achieved a tremendous practical result when he has succeeded in exchanging a sliding contact for a rolling one.

In this article it is proposed to deal with the elimination of friction from ball bearings. This is a matter of great practical importance for the reason that ball bearings are no longer merely the "playthings" of the mechanical engineer. They are, of course, still used in electric fans, carpet sweepers and baby carriages, as there is no doubt of their suitability for these purposes; but they are being increasingly applied to heavy service, and the making of balls has greatly progressed, one at least of our manufacturing companies making and listing steel balls as large as 4 inches in diameter. Ball bearings are being applied to uses where the loads run to twenty-five and fifty tons. They are here to stay, because when constructed in accordance with designs available, with the accuracy possible, and with the steels obtainable, they are capable of tremendously exacting service. The experimental stage is rapidly being passed.

Sources of Friction in Ball Bearings

There are at least four sources of fric-

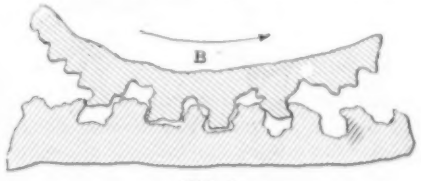


FIG. 4

tion in ball bearings. I enumerate them thus: (1) Rolling friction, arising from the fact that the parts in rolling contact are not absolutely smooth surfaces, and also from the circumstance that contact is so limited; (2) sliding friction, arising from the contact of balls with balls; (3) in four-point bearings, the conflict of the axis of rotation set up by the inner raceway with the axis of rotation set up by the outer raceway; (4) friction arising out of the surface-grind set up through compression between the ball and the bearing surface at a time when this surface is not parallel with the instantaneous axis of rotation of the ball.

The first source of friction—that is, the friction arising from rolling contact—is largely eliminated by increasing the hardness and smoothness of the balls and raceways. The second source of friction—that which arises from the sliding contact of balls with balls—has attracted the attention of many inventors. The point should be emphasized that this friction is a "sliding" and not a rolling one. A little attention to the subject will convince one that the balls are rotating in opposite directions at the point of their mutual contact. It would seem that the only effective

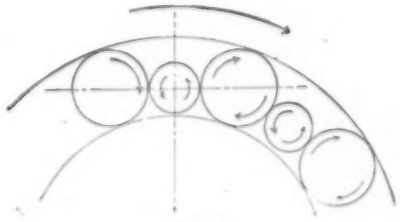


FIG. 5

means of eliminating this source of sliding friction is the introduction of a ball or roller, or the equivalent, between consecutive bearing balls in such a manner that the separating means is not in pres-

sure contact with either raceway. See Fig. 5. A separating device which does not roll would have but little effect, apparently, as the slide would still remain.

THE CONFLICT OF THE AXES OF ROTATION

It is not the writer's purpose to treat of the two preceding sources of friction in detail, but to devote the most attention to the third and fourth sources. Taking up the source of friction to which four-point bearings are subject, and which consists in the conflict in the axes of rotation,

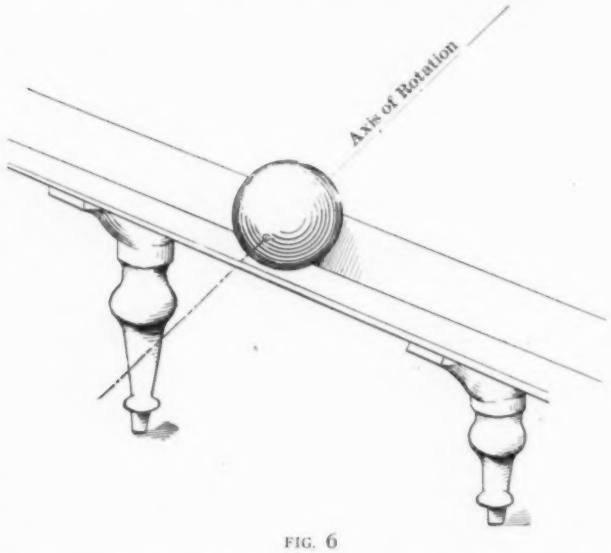


FIG. 6

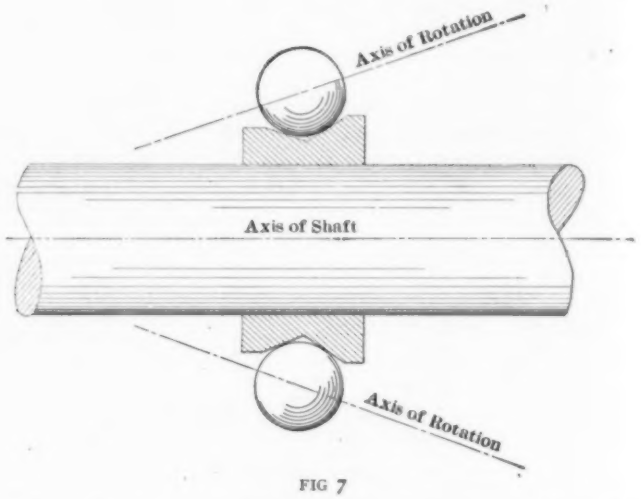


FIG 7

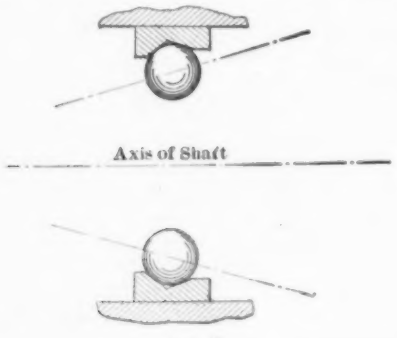


FIG. 8

a little consideration will convince one that when a ball is rolled in a V-shaped groove an axis of rotation is set up. That is to say, two surfaces of contact are sufficient to determine an axis of rotation. An example of this is seen when a ten-pin ball is rolled in the return trough, Fig. 6. Here an axis of rotation is immediately set up. Now this same thing is true whether the ball is rolled along a straight groove, as in the example just cited, or whether the ball is rolled in a circular groove. At every instant it has a certain definite axis upon which at that instant it may be regarded as rotating. Such a definite axis of rotation is set up by a V-shaped groove on a shaft, Fig. 7, and also a definite axis of rotation is set up independently by the V-shaped groove in the housing, Fig. 8. In a four-point bearing these two V-shaped grooves exist simultaneously. And so in consequence there result simultaneously the efforts of the two grooves each to set up its respective axis of ball rotation. It becomes, then, a matter of considerable importance that these two axes of rotation shall in reality not be two but one single axis. That is to say, it is important that the axes should coincide (Fig. 9). Otherwise there is a contest between the two separate axes, which will give rise to a sliding friction.

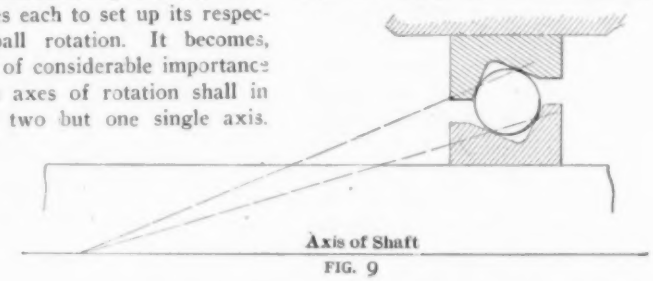


FIG. 9

HOW TO FIND THE AXIS OF ROTATION

It will be instructive to point out how the axis of rotation set up by the contacting surfaces of a V-shaped groove may be found practically. By referring to Figs. 10 and 11 it will be seen that the ball *A* contacts with the bearing ring at the points *1* and *2*, Fig. 10, and at the points *5* and *6*, Fig. 11. Draw a straight line through *1* and *2*, or through *5* and *6*, and prolong it until it intersects the axis of the bearing at *3*. Draw a straight line through *3* and the center of the ball *4*. This line *3—4* is the axis of rotation. It will readily be seen that in order to avoid conflict of the axes when *both* inner and outer V-shaped grooves occur in one bearing it becomes necessary that the lines *1—2* and *5—6*, when prolonged, shall meet the axis of the bearing at the one point *3*, Fig. 12.

Some years ago this matter was dealt with in effect by an Italian inventor named Casalegno. He seemed to think that when he got the lines *1—2* and *5—6* to intersect the axis of the shaft at the same point he had eliminated all sliding friction—at least, all sliding friction due to contact of balls with rings. He was in error as to this, as will appear in the sequel.

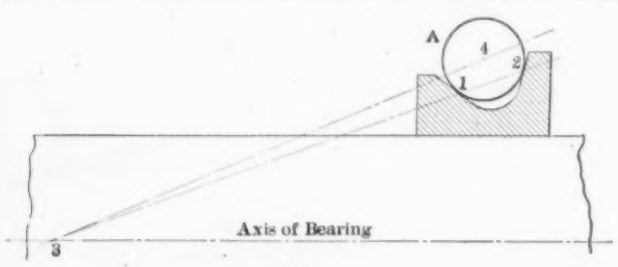


FIG 10

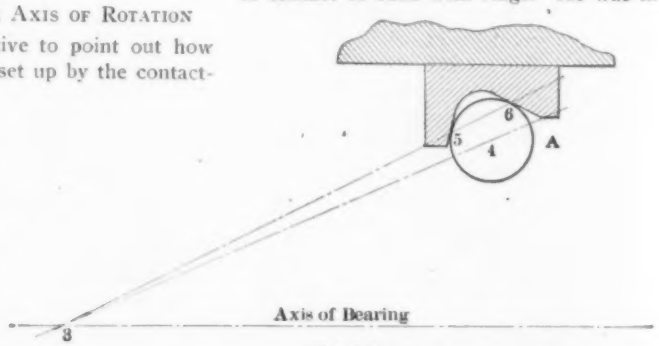


FIG. 11

Before passing on to the next source of friction it will be instructive to call attention to an unnecessary restriction to

which this same inventor thought it necessary to subject the three-point construction. He thought that when one of the bearing rings presented a single surface to the ball instead of a V-shaped groove, the prolongation of this single surface should pass through the point *3*, bearings, then, the conflict of axes which we have been considering does not occur.

THE MOST SERIOUS SOURCE OF FRICTION

Regarding the fourth source of friction—that which arises from the actual rotation of a ball relatively to the contacting surface—if steel balls and steel bearings could be made absolutely smooth and incompressible, and not subject to minute flaking arising from inadequacy of support, this trouble would not arise. As it is, however, the trouble exists and constitutes perhaps the most serious source of friction to which ball bearings are liable. By referring to Fig. 15, which shows to a greatly exaggerated degree the compression between the ball and the race, it will be noticed that the line *1—2* is not parallel to the surface of contact but makes an angle with it.

In order to comprehend clearly the source of friction which the writer is about to explain it will be necessary to understand somewhat the character of the line *1—2*. The technical name for this line is the *instantaneous axis of rotation*. Its character is this: If we take our position on the bearing ring and, disregarding its motion, pay attention only to the motion of the ball relatively to this bearing ring, we shall observe that all points on this line *1—2* are quiescent, that the ball is in fact rotating about this line as an axis. This is the reason for calling the line an axis of rotation. But this axis of rotation is good for an instant only. As the ball rolls, there is a constant change of axis. It is therefore appropriate to call it the *instantaneous* axis of

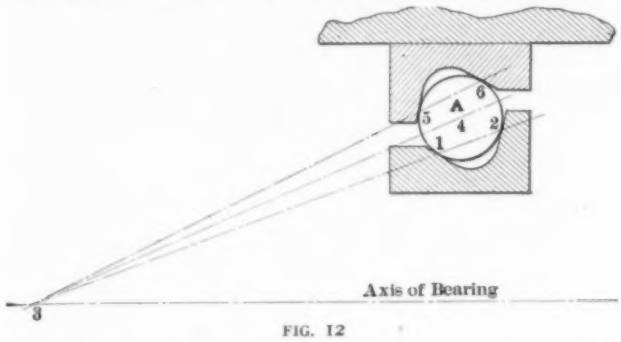


FIG. 12

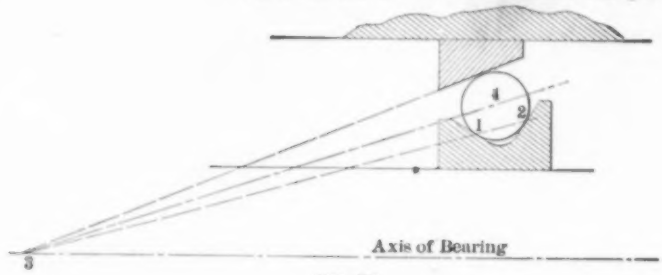


FIG. 13

Fig. 13. In this he was mistaken, in so far as the harmonization of velocities is concerned, for the following reason: *One* point of contact between a surface and a rolling ball is not of itself sufficient to determine a definite axis of rotation. In fact, it harmonizes with any axis whatsoever. If one of the bearing rings, say the inner, has two points of contact with the ball, Fig. 14, and consequently determines a definite axis of rotation, the one point of contact between the outer ring and the ball will not set up an additional axis, but will accommodate itself to the one set up by the inner ring. And

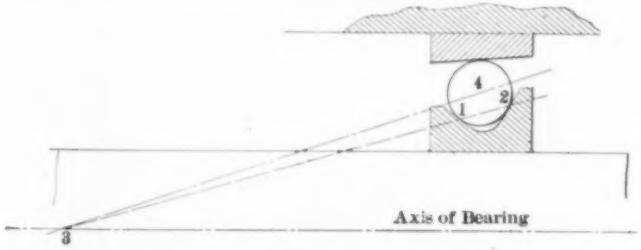


FIG. 14

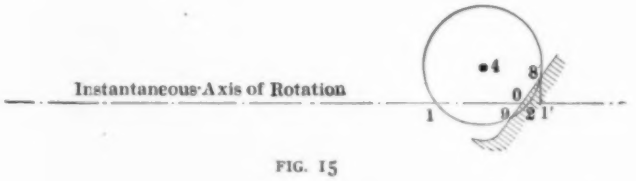


FIG. 15

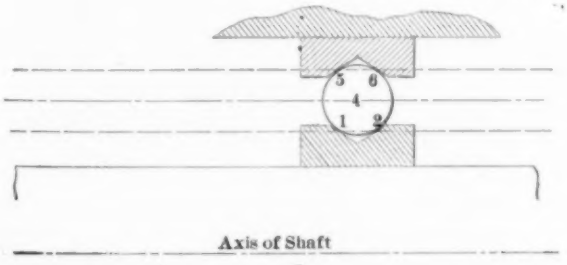


FIG. 16

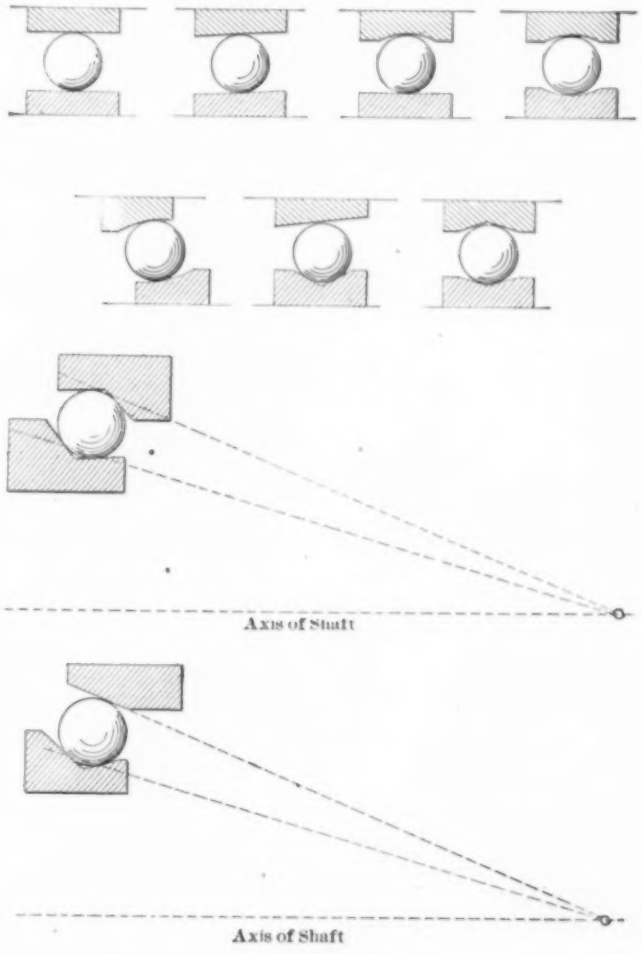


FIG 17

it does not matter where this point of contact of the outer ring is situated. The restriction that it should be so located that the tangent at this point would pass through *3* is unnecessary. In three-point

rotation, seeing that it is the axis for the instant only.

This rotation of the ball relatively to the contacting surface is complicated with compression. By referring again to Fig. 15 it will be seen that all points of the line of contact *8—9*, except *o*, which is quiescent, are swinging in circles about the line *1—2*. Thus, *8* swings in a circle whose center is *1'* and whose radius is *1'—8*. That this gives rise to sliding friction is quite clear. That this friction is approximately proportional to the pressure *along 1—2* would seem to follow as a consequence. It will be readily granted by those who have followed this discussion that here is a most serious source of sliding friction. It will be observed, however, that it disappears as the angle between *1—2* and *8—9* is diminished. It becomes very important, then, from the point of view of the elimination of this source of friction, that this angle should be made as small as possible. The result of all this is that *flat* raceways are an absolute requirement. By *flat raceways* is meant raceways whose sides are parallel, or approximately so, to the corresponding instantaneous axis of rotation. Examples of such raceways are shown in Fig. 17. In contrast with these are shown in Fig. 18 examples of more or less incorrect forms of raceway.

In applying these principles to the special cases where one instantaneous axis of rotation is parallel to the axis of the shaft, let it be noticed that this will have the effect of carrying the point *3*, where the instantaneous axis and the axis of the shaft meet, off to infinity. This will result in requiring the other instantaneous axis to be parallel to the axis of the shaft. So also with the axis of rotation itself. This is brought out in Fig. 16. In such cases it is necessary that *all* bearing surfaces should be parallel, or approximately so, with the axis of the shaft, at least at the several points of contact.

Probably the great bulk of ball bearings, if we except a few styles made in the last few years, have been constructed on more or less erroneous fundamental principles. The time is at hand when a tremendous increase in the application of ball bearings to heavy machinery is about to take place. It is therefore important that the fundamental conditions should be discovered and made known. It is hoped by the writer that the present article is a serious contribution to this difficult subject.

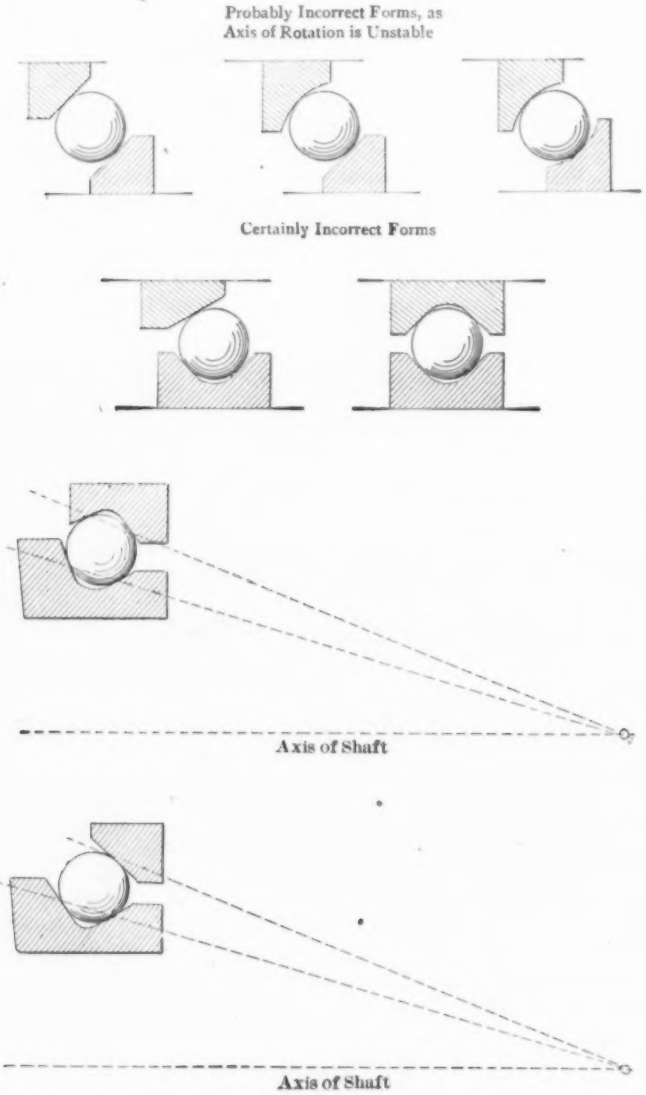


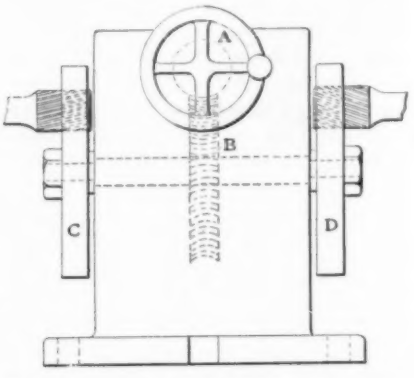
FIG. 18

Cutting Gear Blanks in a Milling Machine

BY F. T. SCHELL

It seems that there are still many places where the value of the milling machine is not fully realized. A good many jobs can be done cheaper and more accurately on it, but simply because they go readily on a shaper or lathe they are never tried elsewhere.

In the accompanying sketch is a jig to cut gear blanks, either bevel or spur, on a double-spindle miller. The worm which is shown by the dotted circles *A* is rotated by the hand wheel and drives worm wheel and mandrel *B*, on which the blanks *C* and *D* are fastened.



JIG FOR CUTTING GEAR BLANKS IN A MILLING MACHINE

By actual test they have been done 40 per cent. cheaper in our shop than on a lathe.

There has been placed in operation at the Jamestown exposition grounds a monorail system, extending over a private right of way for nearly half a mile. A car 47 feet in length and 6 feet wide is used, being driven by eight motors of 20 horsepower each, and considerable interest the country over is attached to this experimental system.

In St. Petersburg an Association for the Promotion of Home Made Articles is in course of organization. It is projected to establish trade schools and workshops in all the principal industrial districts of Russia in order to instruct the workers. Technical improvements are to be introduced and artists and technical experts will be employed to furnish designs and to superintend the labors.

Cylinder Grinder with Revolving Head

A Machine That Grinds Cylindrical Holes with the Work Stationary on the Table and That Cools the Work on the Outside

SPECIAL CORRESPONDENCE

The accompanying illustrations show a novel grinding machine which has been especially designed for the rapid finishing of holes in which an accurate bore is a necessity, such as cylinders for automobiles, gas and steam engines and other castings or parts in which accurately round and straight holes are required.

The construction of this machine has several novel features, one being that it does not require rotation of the work. This makes it specially valuable in finishing holes in castings which are not symmetrical, and which it would be difficult if not impossible, to rotate according to the method usually followed in boring and grinding machines. It also avoids the tendency of unbalanced work to throw itself out of true and in this way affect accurate grinding.

Fig. 1 shows a motor-driven machine and the belt arrangement for the spindle and feed boxes is made clear.

In this latter construction the motor is mounted on the broad base of a column set in the rear of the machine, which column carries at the top a hanger casting with two parallel shafts. The one at the rear drives through a couple of cone pulleys, for variable speed, to the front shaft, and from this direct to the machine as shown.

Adjustment for Varying Diameters

Fig. 2 shows a sectional view of the grinding head together with a portion of the upper part of the column and tables.

The grinding spindle is carried in a sleeve *A* in an eccentric position. This in turn is carried by another eccentric *B*, which rotates about a horizontal axis, giving the grinding spindle and wheel a sort of planetary motion, making a very effective device for adjusting the wheel to grind to any diameter.

On the front of the column is mounted a massive knee having a vertical adjustment of 4 inches, and this carries the main sliding table which travels in a line parallel to the grinding spindle. This table is made heavy with ample wearing surfaces and of sufficient length to fully protect the ways on which it slides, from grit and dust. The main sliding table is provided with a cross-slide table for giving crosswise adjustment to the work with relation to the grinding spindle, the feed screw being graduated to read to thousandths of an inch.

The cross slide table has a traverse of 9 inches and this adjustment greatly reduces the expense of jigs and fixtures for holding the work, so that they will be comparatively inexpensive. The travel of the main table is automatic, reversing accurately at any point desired. The rate of travel is controlled by a change gear box on the front of the column by means of which three different speeds are instantly available for every speed of rotation in the work.

Details of the Spindles

The wheel spindle is hardened, ground and lapped, and runs in phosphor-bronze boxes, shown in Fig. 2, made dust proof and adjustable for taking up wear in a very simple manner. The end of the wheel spindle is made tapering, to receive wheels mounted on collets, thus making it easy to change wheels at any time, with the least possible trouble and delay.

The eccentric head carrying the wheel spindle is driven as shown in Fig. 2, a belt running from the pulley on this lower shaft to the pulley in the change-speed box. Gear *D* is driven by pinion *E* and turns the eccentric head *B*, carrying the wheel, at the desired rate.

This arrangement gives four speeds of rotation to the grinding head—27, 39, 50 and 75 turns per minute, which is of advantage in handling work of different diameters, characteristics and conditions. In general practice the slower rotations are used for roughing out stock and for large holes, the higher rotations being used for finishing and producing a smooth and polished surface.

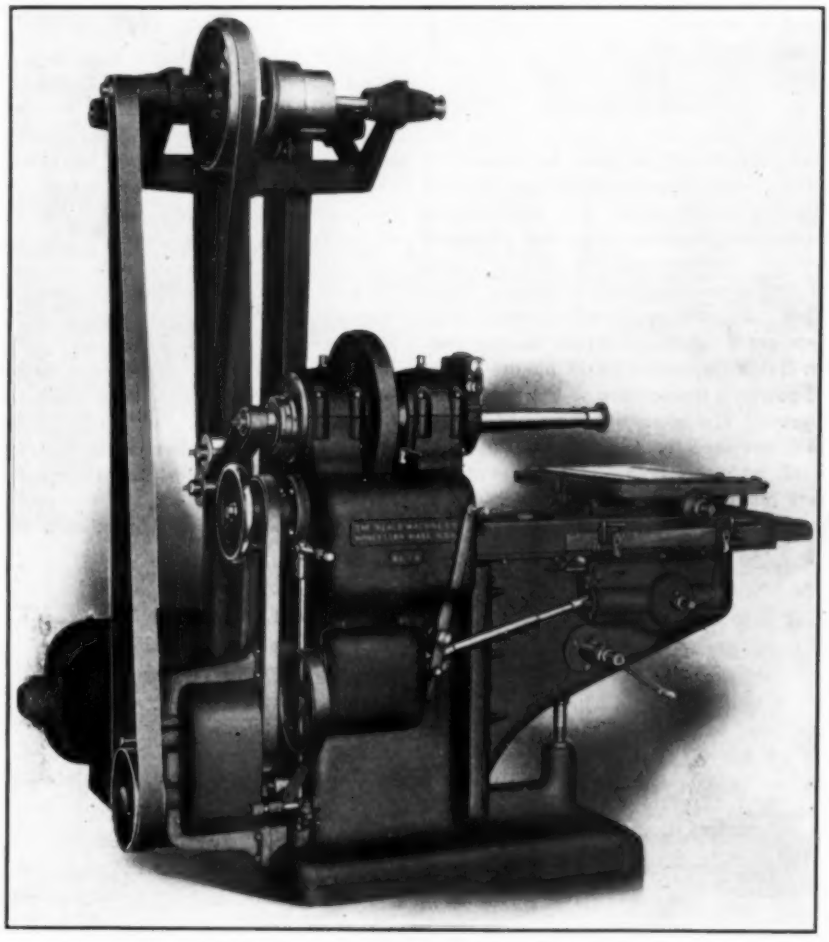


FIG. 1. CYLINDER GRINDER WITH ROTATING HEAD

Range of Work

To obtain holes of different diameter, the inner eccentric *A* is rotated with relation to the outer eccentric *B*, and in this way the radius of the circle in which the grinding spindle and wheel travel is increased or decreased, the minimum diam-

eter of the circle in which the wheel spindle travels being ¼ inch, while the maximum diameter is 3¼ inches. It will readily be seen that the diameter of the hole will always be this diameter, plus the diameter of the grinding wheel.

The eccentric head is fitted with a worm and worm gear for producing this relative adjustment, and a small cog wheel on the worm shaft in connection with a guide mounted on the head of the machine enables adjustments of this diameter to be made while the machine is in motion.

The extension sleeve *H*, supporting the grinding wheel, is made especially heavy and rigid in this machine and carries a spindle bearing in each end.

By means of the vertical adjustment of the knee on the column and the cross movement of this upper table, any adjustment of the work can be made so as to bring a single hole accurately in line with the grinding spindle, or to transfer the work from one hole to another, as is necessary when duplex cylinders are being ground.

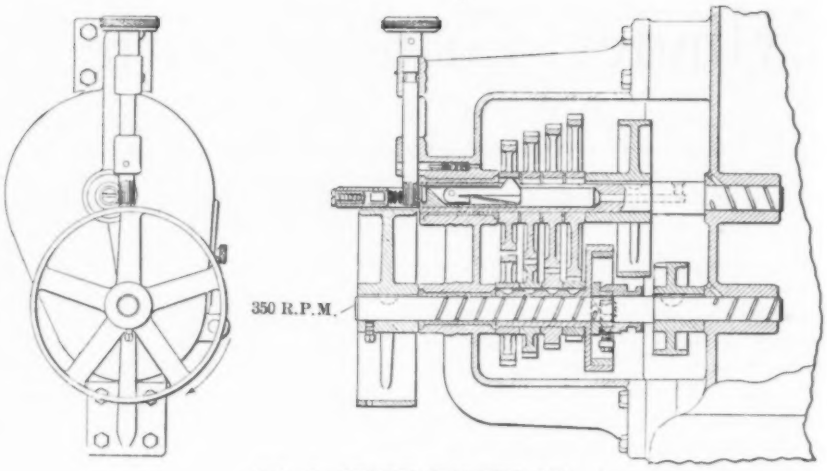


FIG. 3. CHANGE GEAR FEED BOX

Changes of Feed

In the latest machines there is a change-speed gear box at the lower left-hand side of the machine instead of the pair of cone pulleys originally used. The construction of this change-gear arrangement is shown in Fig. 3 and consists of a nest of gears, the lower set being on a driving shaft which is running continuously. This lower set of gears is driven by the friction clutch controlled by the handle above, and power is transmitted to the upper row of gears. The upper shaft contains a pull spline operated by small pinion and hand wheel, and this connects to one of the gears on the shaft on which they rotate, the shaft taking up the speed of the particular gear selected. The other set of change gears is driven from the drive shaft of this, as can be seen.

Why Accuracy Is Claimed

The fact that the wheel rotates in a perfect circle, being turned in the large bearings *C C*, in eccentric head *A A*, insures a perfectly round and straight hole, because the table simply carries the cylinder over the wheel in a perfectly straight line, and every portion of the hole is presented to the wheel in exactly the same position and while the wheel is rotating in a circular path of constant diameter. This obviates the error which comes from boring a piece of work in a lathe or on a boring mill, where the axis of rotation and line of travel of the boring tool may not be exactly parallel.

The wear of the wheel introduces practically no error in this grinding because the wheel, when of the right grade and grit, and when given the proper speed of rotation, will take out, say, 0.003 or 0.010 inch of stock in a 4- or 5-inch hole without wearing down more than about 0.001 inch in diameter during the entire roughing and finishing cuts. And as the wheel passes through the cylinder a number of times, taking several cuts to remove the stock and then lighter ones for the finished surface, any difference in diameter between one end of the cylinder and the other is too small to be measured.

Novel Use of Water

The machines are fitted with a pump and tank for water supply located just in the rear of the main column. The tables also have water channels for properly caring for the water used. The water used in grinding is not thrown on the wheel or over the surface being ground, however, but is allowed to flow over the outside of the casting or work being operated on.

The reason for this is that in internal grinding the makers' experience has been that the wheels seem to cut faster and more satisfactorily dry than wet, and as the purpose of the water in any grinding is simply to maintain an even temperature of the work, the object is attained equally as well with an outside application.

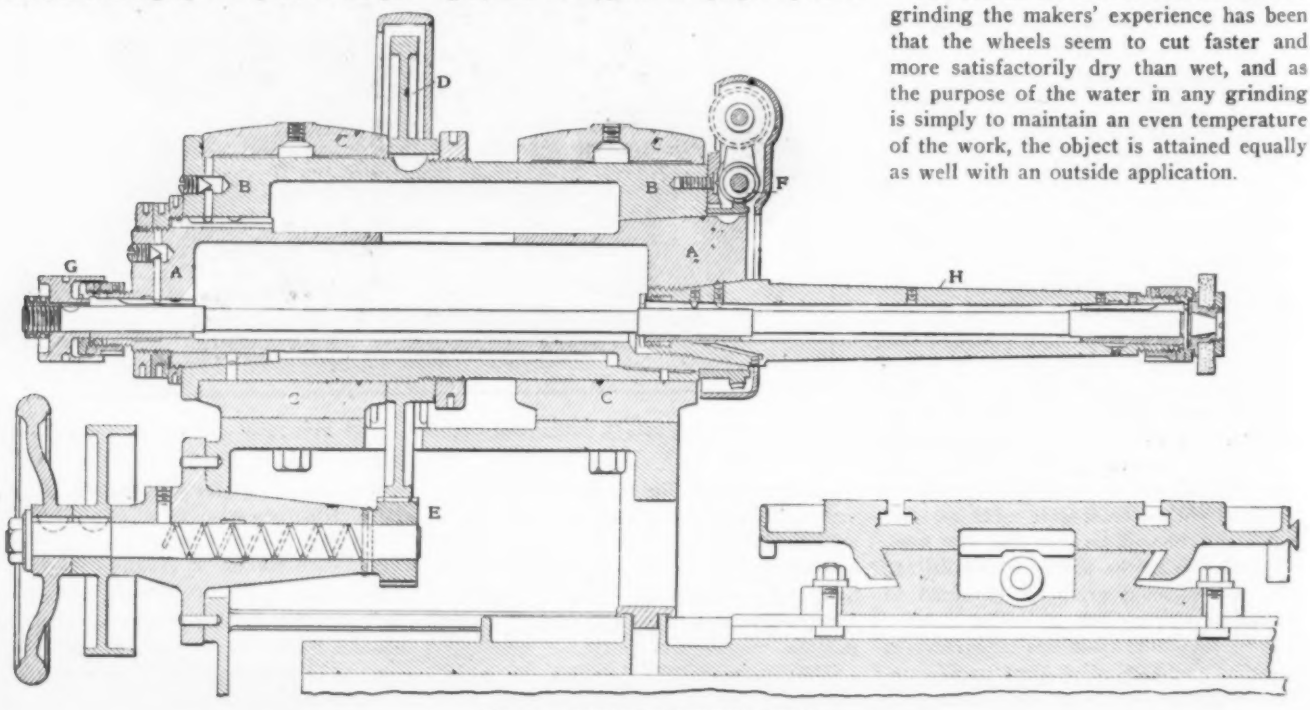


FIG. 2. SECTION OF GRINDING HEAD

In external grinding it is not possible to apply the water anywhere except where the work is being done, but with internal grinding the conditions are different and the wetting of the wheel or finished surface is entirely unnecessary.

Advantages of Grinding

The makers sum up the relative advantage of grinding holes, as compared with boring and reaming, in this way:

The character of the surface obtained is better than that produced by boring and reaming, that being relatively rough and coarse as compared to that produced by grinding.

In boring cylinders having thin walls there is great trouble on account of the thin walls being so likely to spring away from the cutting tool wherever there is a hard spot in the iron. When it springs back, after the tool passes on, it leaves a permanent elevation or friction spot for the piston and rings to chafe against. This causes a leaky place on each side of it, allowing leakage. On the other hand, wherever there is a soft spot in the cylinder walls, the ordinary tool cuts too deeply, creating a depression in the surface, which also lets the gas escape past the piston.

The grinding wheel, however, cuts the metal freely without putting undue pressure on the cylinder walls. The grinding wheel revolves in a true circle, and cuts away the iron until an absolutely round and straight hole is produced, without either high or low spots, leaving a smooth, glossy surface throughout.

With a gas-engine cylinder of this character it is an easy matter to retain compression for a long period, and the general efficiency is correspondingly raised, since leakage of gas past the piston due to high and low spots is wholly eliminated.

The work being ground is a Westinghouse cylinder for an air compressor, such as they use on electric cars, and similar work. The holes are required to be accurately round and straight, as the peculiar style of rings they use makes it of the greatest importance that there should be no variation in diameter.

A user of one of these machines recently brought out the point that he had been able to get holes previously that appeared to be perfectly round. That is, the test gages would pass through and seemed to contact properly at all points. At the head end of the cylinder there was a port on one side for admission of the gas and it developed that directly opposite that port there was always a high place in the castings that were bored and reamed and not ground.

In testing the cylinders with limit gages they would appear perfectly round, but when they came to grind them the grinding wheel took off an extra large amount of material opposite this port, showing that the hole was not straight.

The grinding machine enabled them to get straight holes as well as a better finish, whereas it had previously been impossible for them to do so.

Capacity and Output

The capacity of the machine is for holes from 3 to 8 inches in diameter by 15 inches deep. The rapidity with which work can be turned out on this machine may be indicated by the finishing of holes 5 inches in diameter by 10 or 11 inches long, directly from a rough boring, in from 20 to 40 minutes, removing about 0.010 or 0.015 inch in diameter. As holes of this size have been finished at the rate of about 30 in ten hours' time, the speed depending somewhat upon the character of the iron, the grade and grit of wheel used, and the ability of the operator to handle the machine to good advantage, this may be considered a fair average.

This machine is built by the Heald Machine Company, Worcester, Mass.

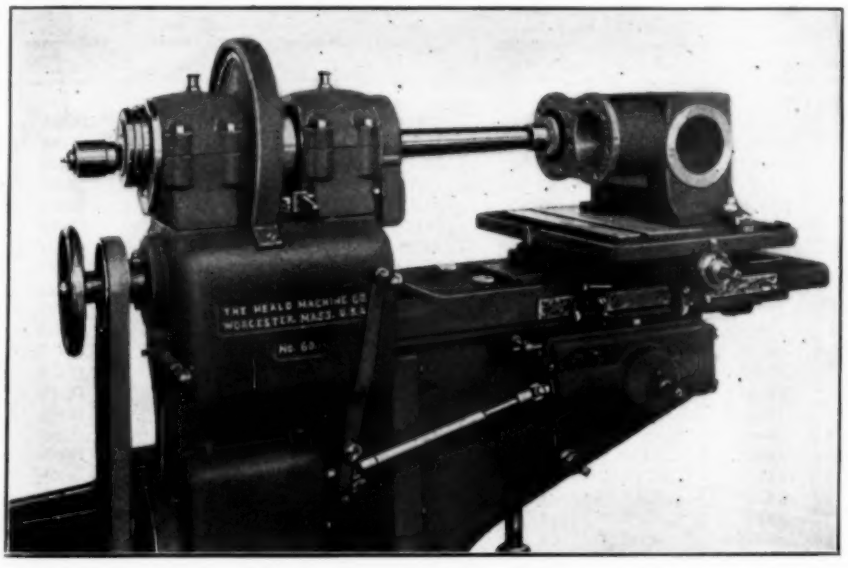


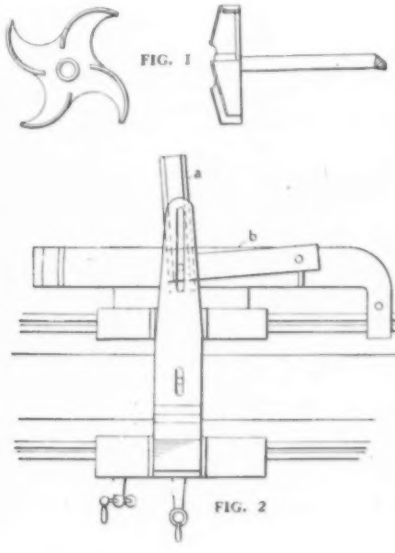
FIG. 4. GRINDING CYLINDERS OF AN AIR-PUMP

Attachment for Turning Bevels

By M. F. Bates

In a western shop manufacturing a line of centrifugal pumps their practice is to drive and key a pump runner previously bored and key-seated on to the finished end of a rough-turned shaft, and to finish both as one piece on centers. The runners are of the form shown (Fig. 1), of gray iron.

It is evident that when turning the shaft and flat side of the runner you would drive from the face plate through to the opposite runner vanes. But the fun begins when you turn the work around and drive through the shaft to finish the bevel edges of the runner.



ATTACHMENT FOR TURNING BEVELS

One day when I was watching a new lathe hand on the job I had my eyes opened when I saw him take out the live center and push the shaft back into the hollow spindle, bringing the finished side of the runner flat to the face plate and holding it there with the dead center.

For facing work on a bevel I use a modification of the usual taper attachment which may be new to your readers.

The guide bar is replaced by an L-shaped piece *a—b*, Fig. 2. The leg *a* forms the guide for the sliding shoe. The leg *b* is provided with the binding bolt. When in use the tool is first brought up to the work for the desired cut. The attachment is then locked to the lathe shear and the cross-feed is used instead of the traverse. It should be understood that the sliding shoe is locked to the cross-slide in the usual manner, but the cross-feed nut is not disengaged.

Standard Proportions of Machine Screws

Since the report of the committee of the American Society of Mechanical Engineers on Standard Proportions for Machine Screws, which was given at page 471, Vol. 29, part 2, a new report was submitted at the meeting in Indianapolis embodying several changes. In fact only three sizes remain the same as before, and the new list has additions which seemed advisable, 21 sizes in all.

The included angle remains 60 degrees as before, and the flat at top and bottom of thread is still one-eighth of the pitch for the basic or standard diameter. There is a uniform increment of 0.013 inch, between all sizes from 0.06 to 0.19 (numbers 0 to 10 in the tables which follow) and of 0.026 inch in the remaining sizes. This change has been made in the interest of simplicity and because the resulting pitch diameters are more nearly in accord with the pitch-diameters of screws in present use.

The pitches are a function of the diameter as expressed by the formula

$$\textit{Threads per inch} = \frac{6.5}{D + 0.02},$$

with the results given approximately so as to avoid the use of fractional threads.

The diagram, which is much less complicated than the one first used and illustrated at page 473, Vol. 29, Part 2, shows the various sizes for both 16 and 72 threads per inch, and shows, among other things, the allowable difference in the flat surface, between the maximum tap and the minimum screw, this variation being from one-eighth to one-sixteenth.

The minimum tap conforms to the basic standard in all respects except diameter. The difference between the minimum tap and the maximum screw provides an al-

STANDARD SCREWS

CORBIN SCREW CORPORATION, NEW BRITAIN, CONN.

Size		Outside Diameters			Pitch Diameters			Root Diameters		
No.	Out. Dia. and Thds. P. I.	Minimum	Maximum	Difference	Minimum	Maximum	Difference	Minimum	Maximum	Difference
0	.060–80	.0572	.060	.0028	.0505	.0519	.0014	.0410	.0438	.0028
1	.073–72	.070	.073	.003	.0625	.064	.0015	.052	.055	.0030
2	.086–64	.0828	.086	.0032	.0743	.0759	.0016	.0624	.0657	.0033
3	.099–56	.0955	.099	.0035	.0857	.0874	.0017	.0721	.0758	.0037
4	.112–48	.1082	.112	.0038	.0966	.0985	.0019	.0807	.0849	.0042
5	.125–44	.1210	.125	.0040	.1082	.1102	.0020	.0910	.0955	.0045
6	.138–40	.1338	.138	.0042	.1197	.1218	.0021	.1007	.1055	.0048
7	.151–36	.1466	.151	.0044	.1308	.1330	.0022	.1097	.1149	.0052
8	.164–36	.1596	.164	.0044	.1438	.146	.0022	.1227	.1279	.0052
9	.177–32	.1723	.177	.0047	.1544	.1567	.0023	.1307	.1364	.0057
10	.190–30	.1852	.190	.0048	.166	.1684	.0024	.1407	.1467	.0060
12	.216–28	.2111	.216	.0049	.1904	.1928	.0024	.1633	.1696	.0063
14	.242–24	.2368	.242	.0052	.2123	.2149	.0026	.1808	.1879	.0071
16	.268–22	.2626	.268	.0054	.2358	.2385	.0027	.2014	.209	.0076
18	.294–20	.2884	.294	.0056	.2587	.2615	.0028	.2208	.229	.0082
20	.320–20	.3144	.320	.0056	.2847	.2875	.0028	.2468	.255	.0082
22	.346–18	.3402	.346	.0058	.3070	.3099	.0029	.2649	.2738	.0089
24	.372–16	.366	.372	.0060	.3284	.3314	.0030	.281	.2908	.0098
26	.398–16	.392	.398	.0060	.3544	.3574	.0030	.307	.3168	.0098
28	.424–14	.4178	.424	.0062	.3745	.3776	.0031	.3204	.3312	.0108
30	.450–14	.4438	.450	.0062	.4005	.4036	.0031	.3464	.3572	.0108

SPECIAL SCREWS

1	.073–64	.0698	.073	.0032	.0613	.0629	.0016	.0494	.0527	.0033
2	.086–56	.0825	.086	.0035	.0727	.0744	.0017	.0591	.0628	.0037
3	.099–48	.0952	.099	.0038	.0836	.0855	.0019	.0677	.0719	.0042
4	.112–40	.1078	.112	.0042	.0937	.0958	.0021	.0747	.0795	.0048
	36	.1076	.112	.0044	.0918	.094	.0022	.0707	.0759	.0052
5	.125–40	.1208	.125	.0042	.1067	.1088	.0021	.0877	.0925	.0048
	36	.1206	.125	.0044	.1048	.107	.0022	.0837	.0889	.0052
6	.138–36	.1336	.138	.0044	.1178	.120	.0022	.0967	.1019	.0052
	32	.1333	.138	.0047	.1154	.1177	.0023	.0917	.0974	.0057
7	.151–32	.1463	.151	.0047	.1284	.1307	.0023	.1047	.1104	.0057
	30	.1462	.151	.0048	.1270	.1294	.0024	.1017	.1077	.0060
8	.164–32	.1593	.164	.0047	.1414	.1437	.0023	.1177	.1234	.0057
	30	.1592	.164	.0048	.1400	.1424	.0024	.1147	.1207	.0060
9	.177–30	.1722	.177	.0048	.1529	.1553	.0024	.1277	.1337	.0060
	24	.1718	.177	.0052	.1473	.1499	.0026	.1158	.1229	.0071
10	.190–32	.1853	.190	.0047	.1674	.1697	.0023	.1437	.1494	.0057
	24	.1848	.190	.0052	.1603	.1629	.0026	.1288	.1359	.0071
12	.216–24	.2108	.216	.0052	.1863	.1889	.0026	.1548	.1619	.0071
14	.242–20	.2364	.242	.0056	.2067	.2095	.0028	.1688	.1770	.0082
16	.268–20	.2624	.268	.0056	.2327	.2355	.0028	.1948	.203	.0082
18	.294–18	.2882	.294	.0058	.255	.2579	.0029	.2129	.2218	.0089
20	.320–18	.3142	.320	.0058	.281	.2839	.0029	.2389	.2478	.0089
22	.346–16	.340	.346	.0060	.3024	.3054	.0030	.255	.2648	.0098
24	.372–18	.3662	.372	.0058	.333	.3359	.0029	.2909	.2998	.0089
26	.398–14	.3918	.398	.0062	.3485	.3516	.0031	.2944	.3052	.0108
28	.424–16	.418	.424	.0060	.3804	.3834	.0030	.333	.3428	.0098
30	.450–16	.444	.450	.0060	.4064	.4094	.0030	.359	.3688	.0098

lowance for error in pitch and for wear of tap in service.

The form of tap thread shown is recommended as being stronger and more serviceable than the so called V-thread, but as some believe a strict adherence to the form shown might add to the cost of small taps, they have decided that taps having the correct angle and pitch diameter are permissible even with the V-thread. This will allow a large proportion of the taps now in stock to be utilized.

The tables given by the committee have been combined into a much more compact form by the Corbin Screw Corporation at the request of other manufacturers, and is kindly furnished us by Horace K. Jones, a member of the committee.

The new standards for the heads of machine screws will appear in the next issue.

In a recent number *The Engineer* reads American railroad engineers a lecture on the standard form of rail as used in this country, which it regards as fundamentally bad and chiefly responsible for the numerous accidents which we have had of late. It regards the chair construction as essentially superior to our own and says: "The flat-footed rail must go ultimately in the United States as it has gone in Europe and India. Traffic in Great Britain is much more dense than it is in America. Our speeds are higher. We have ten fast trains for one in the United States. We have as heavy locomotives, but we have no approach to the number of horrible so-called accidents which are the result of the use of a system of permanent way long since considered out of date by British engineers. If American engineers are wise they will follow the example we have set them."

STANDARD TAPS

CORBIN SCREW CORPORATION, NEW BRITAIN, CONN.

Size		Outside Diameters			Pitch Diameters			Root Diameters			Tap Drill Diameters
No.	Out. Dia. and Thds. P. In.	Minimum	Maximum	Difference	Minimum	Maximum	Difference	Minimum	Maximum	Difference	
0	.060–80	.0609	.0632	.0023	.0528	.0538	.001	.0447	.0466	.0019	.0465
1	.073–72	.074	.0765	.0025	.065	.066	.001	.056	.058	.002	.0595
2	.086–64	.0871	.0898	.0027	.0770	.0781	.0011	.0668	.0689	.0021	.070
3	.099–56	.1002	.1033	.0031	.0886	.0897	.0011	.077	.0793	.0023	.0785
4	.112–48	.1133	.1168	.0035	.0998	.101	.0012	.0852	.0887	.0025	.089
5	.125–44	.1263	.1301	.0038	.1116	.1129	.0013	.0968	.0995	.0027	.0995
6	.138–40	.1394	.1435	.0041	.1232	.1246	.0014	.1069	.1097	.0028	.110
7	.151–36	.1525	.1569	.0044	.1345	.1359	.0014	.1164	.1193	.0029	.120
8	.164–36	.1655	.1699	.0044	.1475	.1489	.0014	.1294	.1323	.0029	.136
9	.177–32	.1786	.1835	.0049	.1583	.1598	.0015	.138	.1411	.0031	.1405
10	.190–30	.1916	.1968	.0052	.170	.1716	.0016	.1483	.1515	.0032	.152
12	.216–28	.2176	.2232	.0056	.1944	.1961	.0017	.1712	.1745	.0033	.173
14	.242–24	.2438	250	.0062	.2167	.2184	.0017	.1897	.1932	.0035	.1935
16	.268–22	.2698	.2765	.0067	.2403	.2421	.0018	.2108	.2144	.0036	.213
18	.294–20	.2959	.3031	.0072	.2634	.2652	.0018	.2309	.2346	.0037	.234
20	.320–20	.3219	.3291	.0072	.2894	.2912	.0018	.2569	.2606	.0037	.261
22	.346–18	.3479	.3559	.0080	.3118	.3138	.0020	.2757	.2796	.0039	.281
24	.372–16	.374	.3828	.0088	.3334	.3354	.0020	.2928	.2968	.0040	.2968
26	.398–16	.400	.4088	.0088	.3594	.3614	.0020	.3188	.3228	.0040	.323
28	.424–14	.4261	.4359	.0098	.3797	.3818	.0021	.3333	.3374	.0041	.339
30	.450–14	.4521	.4619	.0098	.4057	.4078	.0021	.3593	.3634	.0041	.368

SPECIAL TAPS

1	.073–64	.0741	.0768	.0027	.064	.0651	.0011	.0538	.0559	.0021	.055
2	.086–56	.0872	.0903	.0031	.0756	.0767	.0011	.064	.0663	.0023	.067
3	.099–48	.1003	.1038	.0035	.0868	.088	.0012	.0732	.0757	.0025	.076
4	.112–40	.1134	.1175	.0041	.0972	.0986	.0014	.0809	.0837	.0028	.082
	36	.1135	.1179	.0044	.0955	.0969	.0014	.0774	.0803	.0029	.081
5	.125–40	.1264	.1305	.0041	.1102	.1116	.0014	.0939	.0967	.0028	.098
	36	.1265	.1309	.0044	.1085	.1099	.0014	.0904	.0933	.0029	.0935
6	.138–36	.1395	.1439	.0044	.1215	.1229	.0014	.1034	.1063	.0029	.1065
	32	.1396	.1445	.0049	.1193	.1208	.0015	.099	.1021	.0031	.1015
7	.151–32	.1526	.1575	.0049	.1323	.1338	.0015	.112	.1151	.0031	.116
	30	.1526	.1578	.0052	.131	.1326	.0016	.1093	.1125	.0032	.113
8	.164–32	.1656	.1705	.0049	.1453	.1468	.0015	.125	.1281	.0031	.1285
	30	.1656	.1708	.0052	.144	.1456	.0016	.1223	.1255	.0032	.1285
9	.177–30	.1786	.1838	.0052	.1569	.1585	.0016	.1353	.1385	.0032	.1405
	24	.1788	.185	.0062	.1517	.1534	.0017	.1247	.1282	.0035	.1285
10	.190–32	.1916	.1965	.0049	.1713	.1728	.0015	.151	.1541	.0031	.154
	24	.1918	.198	.0062	.1647	.1664	.0017	.1377	.1412	.0035	.1405
12	.216–24	.2178	.224	.0062	.1907	.1924	.0017	.1637	.1672	.0035	.166
14	.242–20	.2439	.2511	.0072	.2114	.2132	.0018	.1789	.1826	.0037	.182
16	.268–20	.2699	.2771	.0072	.2374	.2392	.0018	.2049	.2086	.0037	.209
18	.294–18	.2959	.3039	.0080	.2598	.2618	.0020	.2237	.2276	.0039	.228
20	.320–18	.3219	.3299	.0080	.2858	.2878	.0020	.2497	.2536	.0039	.257
22	.346–16	.348	.3568	.0088	.3074	.3094	.0020	.2668	.2708	.0040	.272
24	.372–18	.3739	.3819	.0080	.3378	.3398	.0020	.3017	.3056	.0039	.3125
26	.398–14	.4001	.4099	.0098	.3537	.3558	.0021	.3073	.3114	.0041	.316
28	.424–16	.426	.4348	.0088	.3854	.3874	.0020	.3448	.3488	.0040	.348
30	.450–16	.452	.4608	.0088	.4114	.4134	.0020	.3708	.3748	.0040	.377

The Demand for American Machinery in China

By F. C. Chappell

There can be no doubt whatever that business in China is decidedly waking up. British trade, for example, with the celestial empire has doubled within the last five or six years, having risen during that period from 9½ million to over 17 million pounds sterling. That the expansion is general may be gathered from the fact that the total foreign trade of China has risen from 70 million to 107½ million pounds. Six years ago the foreign trade of the country was at the rate of three shillings and sixpence (87c.) per head of the population; it has now increased to four shillings and ninepence ($1.18) per head, while there is every indication that the improvement will continue. During the last five years the value of British exports of machinery and mill work to China has risen from £171,000 to £506,000; implements and tools from £16,000 to £25,000; hardware from £32,000 to £55,000. These are a few samples of how British trade has been expanding, and it would perhaps be as well for American firms to see that they, too, are getting their share of the favors. So energetic are our people in this direction that one English commercial journal is arranging to publish an edition in China.

Nor is this prosperity confined altogether to Great Britain. On the contrary, there has been a phenomenal development of trade between the United States and China. Comparing the year 1906 with 1904, the value of United States exports thither were two and a half times greater, and have practically quadrupled since 1903. The growth is especially marked in locomotives, sewing machines, general mechanical appliances and hardware. With reference to sewing machines, these have been coming into favor in all parts of the empire, and their use will certainly greatly extend, as, although the cost of a machine is about equal to the wages of one man for a year, the saving in labor is equal to the pay of four to ten men, according to the work done. At the busy port of New Chwang there are over one hundred in use; nearly every tailor's shop is provided with one, while hundreds of machines are sold from this district alone for use in the interior. The Chinese, too, are beginning to take to foreign stoves for heating their homes, and their use is very likely to extend.

There is a big market for such goods, as the winter in Manchuria is long and very cold. A native firm makes small stoves of a foreign pattern, weighing about 50 and 70 pounds, and costing five and seven dollars, respectively (Chinese currency). The annual output of such stoves equals fully one thousand and the demand for a better article is increasing, partly owing, no doubt, to the needs of the large number of Japanese who reside there. The material generally used is old iron from abroad.

Cotton compressors would also sell well. The bales of raw cotton shipped from most Chinese ports are of unusual bulkiness, and an installation for compressing them, by hydraulic or other power, would certainly stand a good chance of paying handsomely. Windmills and rice-hulling machinery would also do well. These are especially wanted in the district of Amoy. Many Chinese land owners, interested in rice culture, have visited French plantations in South China, and there they have had ocular evidence of the benefits of improved and labor-saving machinery. They have seen wind pumps doing the work of the Chinese trough-and-paddle arrangement, and have seen modern rice-hulling machinery doing the work of the Chinese coolie, who beats the hulls from rice by pounding it for hours at a time. These object lessons have had their logical result, and there is talk among Chinese plantation owners of purchasing wind pumps, hullers and allied machines. There is always a steady power for wind pumps, as the rice fields are exposed to the monsoons, and such pumps would be a great success.

There is, too, a market opening up for the mechanical parts of motor boats. The whole of China is a network of canals and rivers, upon which motor boats can be worked. At present the usual way of traveling is by house boat, towed by a steam launch. Where the regular lines of steam launches do not run, the old-time house boat with a scull is used. They are terribly slow and very unpopular. There is a growing feeling in favor of power boats for private and public service. The motor boat, as now made, is very little known in China. The Chinese are good boat builders and it would be quite practicable for the machinery to be shipped there, while the hulls were made locally.

As an instance of the progress of China I may state that 20 years ago there was only one short line of railroad in the country; now there are several lines, and many more are being built or are under consideration. There was then but one mill with foreign machinery in Ningpo; today there are several large cotton mills with the latest and best machinery. In Shanghai there are over one hundred. Iron, steel and other mills are frequently being erected. Twenty years ago not a steam vessel of any sort was allowed to run in any waters except at the treaty ports; now the rivers are covered with small steamers. In 1890 there was only one store in China where various classes of American goods could be obtained; today there are hundreds of such stores.

These are the facts that explain the figures quoted relative to the expansion of British and American trade in China. The only effectual way to get hold of some of this business is to send an accredited agent

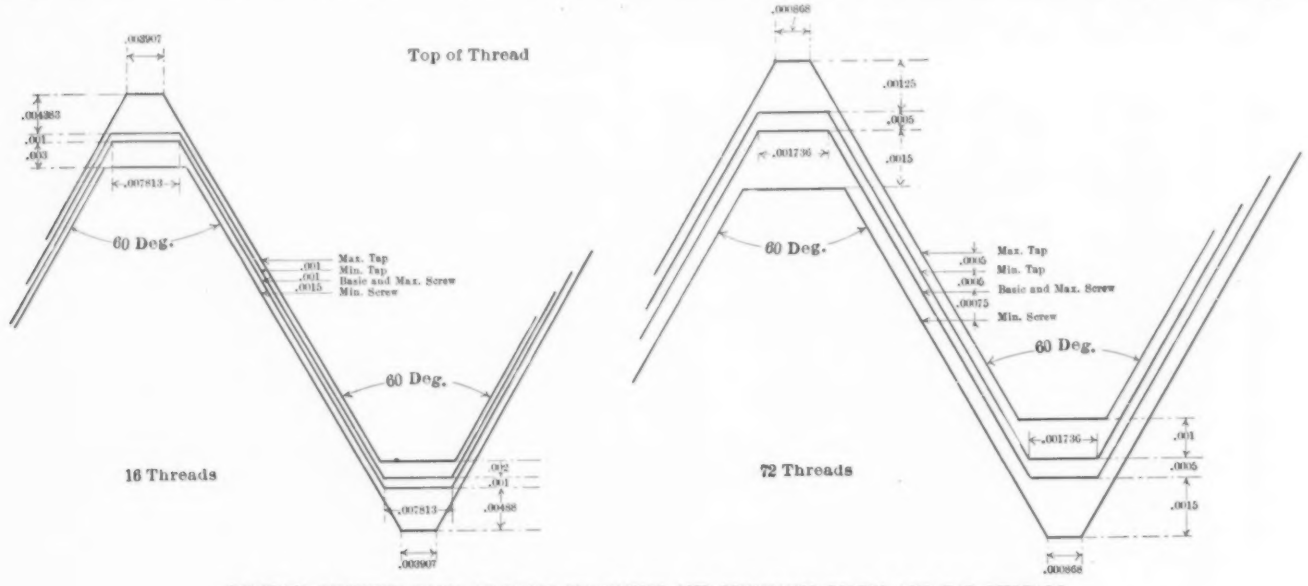


DIAGRAM SHOWING FORM OF BASIC MAXIMUM AND MINIMUM SCREW AND TAP THREADS

to the officials in charge of good undertakings requiring machinery—such as factories, railroads, etc.—so that they may show the advantages of American appliances. The same must be done with native merchants. It is the manufacturer who must go to the expense of pushing his goods and creating a demand for them. When that is accomplished he can safely leave the rest to the resident merchant. The demand for all mechanical goods will grow, but it will grow more quickly if the Chinaman is not left to discover the advantage of them unaided.

A Question in Designing a Press Frame

By R. Howard Duncan and Ferdinand Peam

The problem propounded by Con Wise under the above heading in the American Machinist at page 677, Vol. 30, Part 1, though of very much greater interest than the one on "Cast-iron Beams," will probably not prove to be as productive of discussion, owing to the extreme difficulty of many of the points to which it gives rise. It is probable indeed that there are not above half a dozen men in the world who could offer anything approaching a complete solution of the problem. We propose, however, to attempt to throw a little side light on the questions involved.

Erroneous Use of Ultimate Strength Instead of Modulus of Elasticity

In the first place, Con Wise has fallen into the fallacy, all too common among those who have the proverbial "little knowledge," of assuming that the distribution of stress in a beam section depends upon the *ultimate strength* of the material. As is evident upon a study of the beam theory, the relation between the ultimate strengths of the portions of the section has absolutely nothing whatever to do with the distribution of stress over the section. The all-important factor is the relative yield of the materials under stress, that is, the ratio of the moduli of elasticity. This error entirely accounts for the difference in the positions of the neutral axis shown in Figs. 2 and 4, p. 677.

The Usual Theory Regarding Such a Case of Combined Flexure and Tension

The ordinary theory of structures subjected to combined bending and direct stresses assumes a bending moment on the section ($A\,B$ in Fig. 1, p. 677), due to the eccentricity of the loading, together with a direct stress uniformly distributed over the section. Moreover, the beam theory, which is applied in order to find the stress due to bending, assumes that the modulus of elasticity of the material in tension is equal to that of the material in compression; it also only holds good while the material is perfectly elastic. This is an important point, as is evidenced by some of the contributions on "Cast-iron Beams."

The Direct Tensile Stress

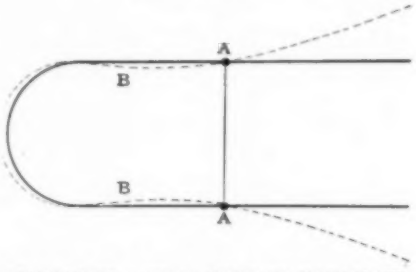
Dealing first with the direct stress, we assume that, as a result of this, the back of the frame will extend the same amount as the bolts, and that the length of gray iron subject to this direct tension is the same as the length of the steel bolts. It should be distinctly understood that there is no theoretical ground for this assumption, but it is the most convenient approximation to make and therefore we adopt it.

Calculation of the Direct Stresses

Then let

x = the actual extension per inch, that is, the strain of both the steel bolts and the gray-iron press back;

f_s = stress per square inch on the steel bolts;



BENDING OF A STEEL BAND TO ILLUSTRATE A POSSIBLE REVERSAL OF FORCES ACTING ON THE BACK OF THE PRESS FRAME

f_1 = stress per square inch on the gray iron back;

L_s = total load in pounds on the steel;

L_1 = total load in pounds on the iron;

A_s = area of steel = 6.28 sq.in.;

A_1 = area of iron = 32 sq.in.;

E_s = Young's modulus of elasticity for steel = 30,000,000 pounds per square inch;

E_1 = Young's modulus of elasticity for cast iron = 15,000,000 pounds per square inch;

P = punching pressure in pounds, as stated by Con Wise.

We have

$$x = \frac{f_s}{E_s} = \frac{f_1}{E_1} = \frac{L_s}{A_s E_s} = \frac{L_1}{A_1 E_1}.$$

But, taking P = 40,000 lb., $L_s = 40{,}000 - L_1$.

$$\therefore \frac{L_1}{32 \times 15{,}000{,}000} = \frac{40{,}000 - L_1}{6.28 \times 30{,}000{,}000}.$$

Whence,

L_1 = 28,700 lb. (approximately) and L_s = 11,300 lb.

$$f_1 = \frac{28{,}700}{32} = 900 \text{ lb. per sq.in.}$$

$$f_s = \frac{11{,}300}{6\ 28} = 1800 \text{ lb. per sq.in.}$$

The Bending Stresses

Turning now to the consideration of the bending stresses, we shall assume that the bolts are rigidly held at their ends so that they may be considered to form an integral part of the frame, taking their share of the resistance to bending.

Position of the Neutral Axis

The beam section will be made up of two parts: (a) the gray-iron back, and (b) the steel bolts. Since these are of different materials the neutral axis will not pass through the centroid* of the section. We may, however, substitute for the steel bolts an equivalent area of gray iron. The equivalent area required will be the area of the bolts increased in the ratio, not of the *strength*, but of the *modulus of elasticity* of steel to that of gray iron, that is, the ratio

$$\frac{30{,}000{,}000}{15{,}000{,}000} = 2.$$

That is, we shall require *four* 2-inch iron bolts in order that they may have the same extension under the same total load as the original two 2-inch steel bolts. The area of these bolts works out at 12.5 sq.in. approximately and the area of the frame section is 32 sq.in.

Therefore, taking moments about h (Fig. 2, p. 677) we have:

distance of centroid from h =

$$\frac{32 \times 4 + 12.5 \times 12}{44.5} = 6.25 \text{ inches},$$

which defines the position of the neutral axis.

Calculation of the Bending Stresses

Let

I = the moment of inertia, or second moment of the whole equivalent section about the neutral axis, in biquadratic inches.

Z_c = the compression modulus of the section in inch^3 units;

Z_t = the tension modulus of the section in inch^3 units;

y_c = distance of compression skin from neutral axis in inches;

y_t = distance of tension skin from neutral axis in inches;

f_c = maximum skin stress in compression in pounds per square inch.

f_t = maximum skin stress in tension in pounds per square inch.

M = bending moment on the section in pound inches.

P = the punching pressure = 40,000 lb.

Then,

$$I = \frac{4 \times 8^3}{12} + 4 \times 8 \times 2.25^2 +$$

*Center of mass; here, the same as center of gravity.—Ed.

$$= 4\left(\frac{\pi \times 16}{64} + 2^2 \times \frac{\pi}{4} \times 5.75^2\right)$$

$$= 750 \text{ inch}^4 \text{ units.}$$

$$Z_c = \frac{I}{y_c} = \frac{750}{6.25} = 120 \text{ inch}^3 \text{ units.}$$

$$Z_i = \frac{I}{y_i} = \frac{750}{6.75} = 110 \text{ inch}^3 \text{ units.}$$

$$M = 40{,}000 \times (12 + 1.75) = 550{,}000 \text{ lb.in.}$$

$$\therefore f_c = \frac{M}{Z_c} = \frac{550{,}000}{120} = 4580 \text{ lb. per square inch.}$$

$$f_i = \frac{M}{Z_i} = \frac{550{,}000}{110} = 5000 \text{ lb. per square inch.}$$

The Actual Stresses Equal to the Algebraic Sums of the Direct and Bending Stresses

The skin stress on the intrados of the frame is, however, less, in the proportion of its distance from the neutral axis and is therefore

$$= \frac{5000 \times 1.75}{6.75}$$

$$= 1300 \text{ lb. per square inch.}$$

To this we must add the previously found direct stress of 900 pounds per square inch, making a total tensile stress on the intrados of 2200 pounds per square inch.

The compressive skin stress on the extrados is $4580 - 900 = 3680$ pounds per square inch and the maximum skin stress on the bolts (on the edge farthest away from the back of the frame) $= 5000 + 1800 = 6800$ pounds per square inch.

Effect of the End Conditions of the Bolts

It seems to us, however, that the method of end-holding of the bolts will have some effect, possibly an important effect upon the distribution of stress in the frame. If, for example, the ends were freely hinged or pin-jointed, the distribution of stress in the bolts will be uniform over their area, and the pull in them may be considered to produce a secondary bending moment, of opposite sign to the primary, on the back of the frame.

If the throat of the press were very deep, and the bolts very heavy and rigid, this secondary bending moment might become sufficiently great to reverse the stresses in the back of the frame, putting the intrados into compression and the extrados into tension. That this action may take place can be shown very clearly experimentally by bending a steel strip as shown in the sketch herewith. If a force be applied to the free ends while the points $A\,A$ are held at a fixed distance apart, the strip will assume a new profile as shown by the dotted lines, points of contra-flexure being developed in the neighborhood of $B\,B$. It is an extremely difficult matter to calculate for a practical case the exact conditions under which this takes place—the exact method of holding the bolts, their positions on the arms and the sections of the arms themselves at various points being a few of the factors which have to be taken into account.

A Dead Load Was Assumed in the Calculations

It must be particularly noted that the above stresses are all worked out on the assumption of a dead load, which would only be approximated to in a slow-acting hydraulic or screw press; if, however, the load is suddenly applied, as in a belt-driven crank press, all these stresses must be doubled.

Bolts Assumed to Be Free from Initial Tension

We have also, of course, made the assumption that there is no initial tension in the bolts. If there were, the results arrived at would be very different; but certainly an initial tension would materially strengthen the frame as a whole.

This Case Analogous to Crane Hooks —Unreliable Theories

But there is another point for consideration, which opens up yet further difficulties. We have hitherto been assuming that the ordinary "hook theory" or method of treating combined stresses is true, but this has recently been shown to be very far from the truth for beams with a curved profile such as a crane hook or the case under consideration in this article. Engineers have for some time known that the strength of crane hooks is much less than this theory would lead us to expect, and various attempts have been made by Winkler, Bach and Tolle to offer a rational explanation of the discrepancy. Recent researches by E. S. Andrews and Prof. Karl Pearson have, however, shown all these theories to be in error.* They have shown that when the ordinary hook theory is applied to beams of curved profile the results obtained are extremely inaccurate and misleading, the direct stress in such beams not being uniformly distributed over the section as the old theory supposes. The error becomes much greater as the radius of curvature of the beam diminishes.

The Matter Probably Indeterminate by Purely Mathematical Means

In view of all these difficulties and uncertainties we think therefore that we are justified in expressing the opinion that the problem under consideration is for all practical purposes indeterminate, and that it is very improbable that anything of the nature of an exact determination of the stresses can be obtained. We have given the above approximate solutions, not with any pretense that they offer anything like a true solution, but in the hope that they may afford some slight clue to the actual stresses which may be produced.

Leeds, England.

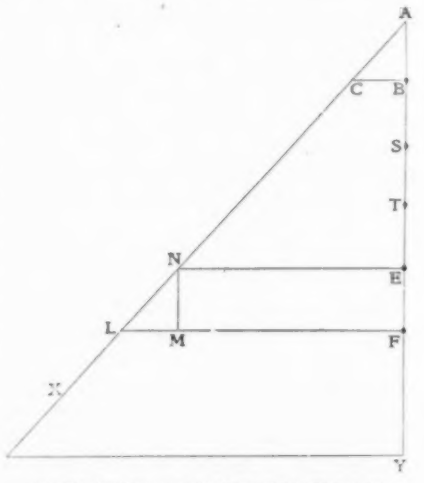
*See "On the theory of the stresses in crane and coupling hooks, with experimental comparison with existing theory," Draper's Company Research Memoirs Tech. Series I. London, 1904. See also "An Experimental Investigation of the Maximum Stresses in Loaded Crane Hooks," by Prof. John Goodman. Proc. Inst. C. E. Vol. CLXVII, 1906-7.

A Graphical Solution for Problems Involving Accelerated Motion

By G. A. Tench

Problems involving accelerated motion, like bodies falling in air, often prove quite difficult of solution. One reason for this is, that we must remember formulas and constants. Like many other problems in mechanics, these problems can be easily solved by graphics.

Everyone knows that a body falling free in air has a velocity of thirty-two feet after one second, and that it traverses sixteen feet during the first second. Referring to the accompanying figure, we draw the vertical line $A\,Y$ and let $A\,B$



A GRAPHICAL SOLUTION FOR PROBLEM

represent one second of time. From B we draw $B\,C$ to represent, to some convenient scale, the velocity thirty-two feet. Through A and C we draw the indefinite line $A\,X$.

Now suppose we wish to investigate the motion at the end of five seconds. In our figure, verticals are time; horizontals are velocities; and areas are distances. Thus, $L\,F$ is the velocity after five seconds; $A\,L\,F$ is the distance traversed in five seconds; $L\,F\,E\,N$ is the distance traversed during the fifth second, and $L\,M$ is the acceleration during the fifth second.

Any of the three variables may be wanted and by drawing a triangle we can figure any of these unknown values with a twelve-inch scale.

The acceleration can have any value and it need not be a uniform acceleration. In such a case the line $A\,X$ is a curve following some given law.

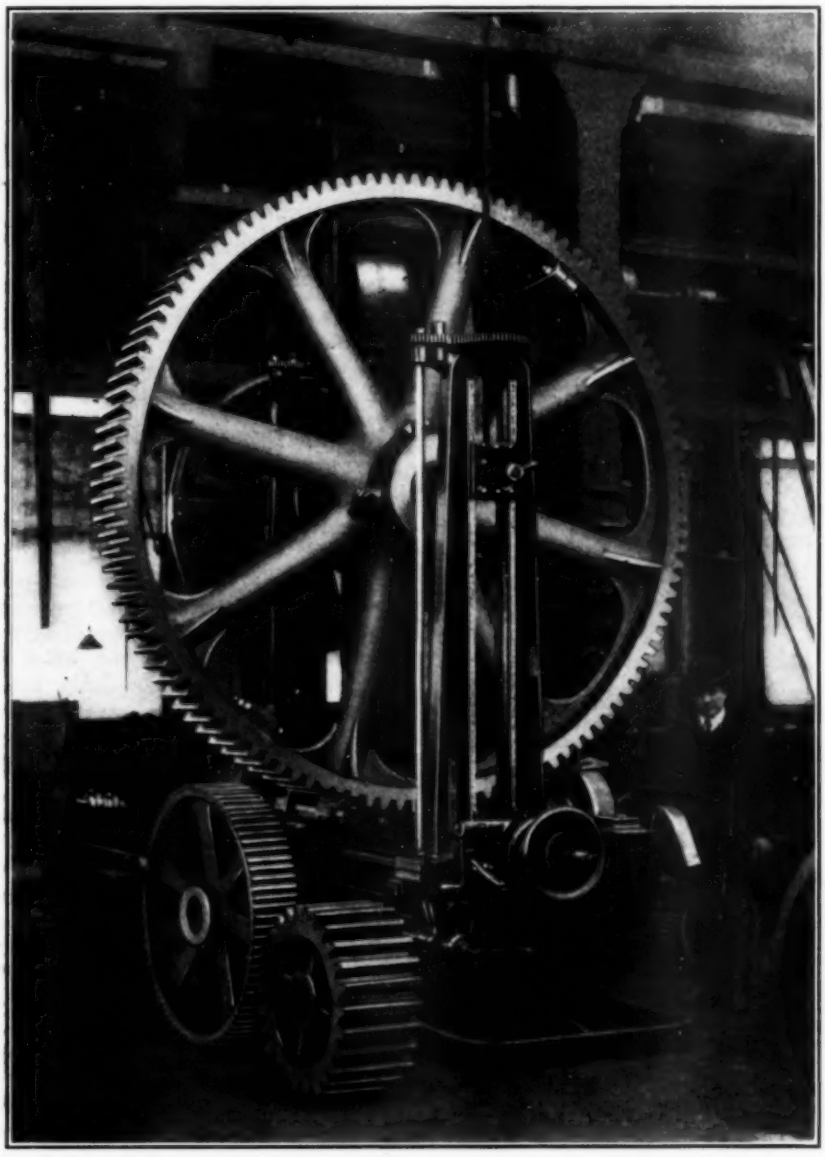
Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Ten-foot Cut Gear Wheels

Some time ago a well-known machine-tool builder in Pennsylvania asked me if it is possible to cut a gear having large diameter and large diametral pitch. I have had a great deal of experience in cutting large gears, and I find that they can be cut as perfectly as small gears. A short time ago I cut a gear measuring 120 inches pitch diameter, and 1 diametral pitch, 16 inches face, cast steel cut on a Gould & Eberhardt 120-inch machine.



A TEN-FOOT CUT GEAR WHEEL

This gear was tested by various engineers and they found only 0.003 inch variations in the teeth, using a Brown & Sharpe gear-tooth caliper. Nine of these gears were placed in the Philadelphia fire department water pumps. Several daily papers stated that these gears did not make any more noise than a sewing machine. The pinion that runs with this gear has only 16 teeth, and runs 300 revolutions per minute. These gears were finished with two cuts, roughing and finishing. I used 1⅛ inches feed in 1 minute for roughing cut and ⅞ inch for finishing cut, the machine carrying this feed very nicely. A. BAXTER.

Fiber Bushings for Grinding

Seeing Mr. McGiven's description on page 889 of how he used fiber for his internal-grinder spindle bearings caused me to think that possibly my own experience with that material might be of interest. I use a number of rollers on a small machine for stripping or nipping defective cigarettes, i.e., splitting them open and separating the paper from the tobacco, which is used over again.

This is done by means of tapes running over small rollers, which revolve at about 5000 or 6000 turns a minute. The spindles are "dead" and are made of No. 19 drill rod, hardened and very slightly drawn, while the rollers are made of hard rubber, bushed with ½-inch fiber rod forced in.

Before I hit on the fiber I tried everything I could think of, from hardened tool steel, gray iron and bronze to babbitt, apple wood and solid graphite, but nothing would last more than a few days. The fiber, which is, I believe, commercially known as vulcanized fiber, and is largely used in the electrical trades, lasts several weeks and sometimes as long as five or six months.

The lubricant used is No. 3 or No. X Albany grease, put on the spindle with the finger twice a day, first removing the roller and cleaning out the hole. We found oil quite useless, as it is thrown out in a few seconds, and the spindles get red hot inside of a couple of minutes. I have to drill the holes in the fiber about No. 16 or 17, as it seems to contract quite a lot after drilling. JOHN P. WHEELER.

Fine Adjustment of Tool Blocks on American Lathes

On page 532 was an article describing a fine adjustment of a tool block and a detailed description, with sketches. Evidently Conrad is an American correspondent, or at all events the trouble he writes of is a general one with American lathes. This trouble is one of the defects of the Yankee machine-tool designers, and a fault they seem to be very slow to recognize.

It is not possible to get a positive adjustment with the usual device arranged on these lathes, a narrow sliding block clamped to the slide, which, either from imperfect fitting or from the weakness of the clamping screw, will slip; on occasions it has caused me to spoil an im-

portant piece of work. Even if the clamp is positively locked to the slide, we have to take into consideration the uncertain behavior of the screw fitting into the slide, the probability of the screw being a loose fit and with a little extra pressure giving three or four times the amount of feed it was set to give. If the operator is taking the finishing cuts on a tap, screw hob, or a particular screw of any description, the work may be ruined.

In my opinion nothing can excel a dial fixed on the end of the cross-slide screw, with a graduated edge and a stationary pointer, or else a dial with a notched edge and a jointed spring latch to engage with the notches, which will prevent the troubles alluded to and, provided the dial is of sufficiently large diameter, will admit of an exceedingly fine and positive adjustment.

W. B. ROBINSON.

Repairing a Crank-shaft

I herewith show a job done on the improvised turret lathe shown at page 565.

Fig. 1 is a one-piece crank-shaft out of a small tugboat. It broke at *A*. The old pin was cut away on the shaper, and the webs were then laid out for holes ½ inch smaller. Then we clamped an angle plate *X* on the turret *Y*, and clamped the web to it, first inserting two thin parallels *P*. We lined it up both ways with the shears of the lathe.

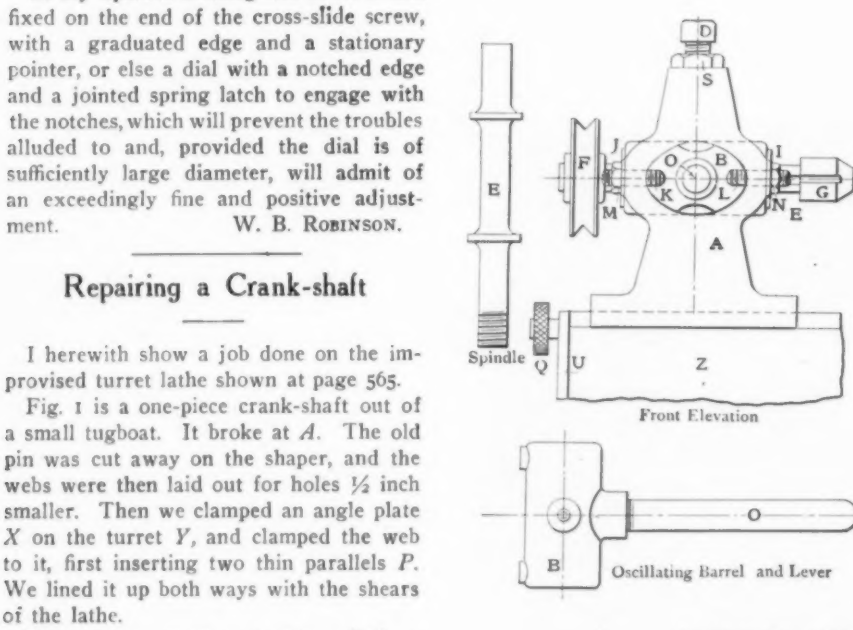
Then we screwed on to the spindle a cutter head *B*, as shown in Fig. 2. *E* is the cutter, made of ⅜x1½-inch high-speed steel. *C* is a 1¼-inch slotted piece, cutter *E* slipping through a slot; when pushed into the end of *B*, *C* extends back past *D* to receive a key which tightens the cutter in place.

We had a drill socket that fitted this head in the same manner. It was first used to drill a hole through the web. The tit *C*, extending ahead of the cutter, guides it.

After each piece was bored and countersunk at the back, we turned up a crank-pin. Next we heated the long piece carefully around the hole, and shrunk the pin in. Then taking four V-blocks, we put two under this section on the planer bed and fastened it down with clamps and bolts, leaving room enough to get the short section on too. Next, the short section was heated, dropped into V-blocks, slipped on to the pin, clamped down and a C-clamp put on close to the pin. When cooled off we riveted the pin in. A ½-inch screw was put in each end to avoid turning; when hung on the centers of a lathe it only required a 1/32-inch cut to true up at the bearings.

The whole job took only eight hours.

J. WATSON.



FIXTURE FOR SLOT-DRILLING COTTER HOLES

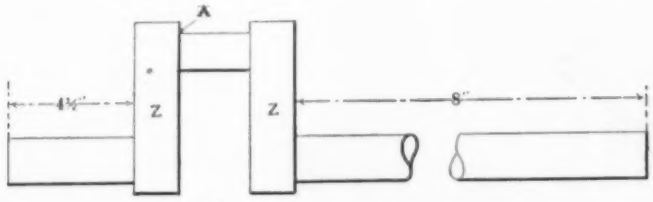


FIG. 1

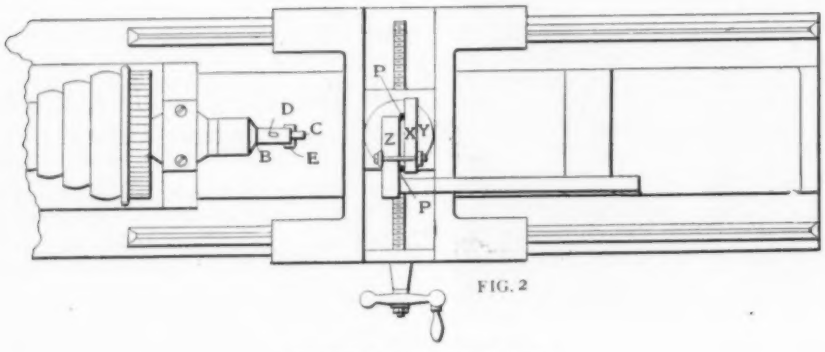


FIG. 2

REPAIRING A CRANK SHAFT

A High-speed Cotter-hole Cutting Machine

On page 254 a correspondent gave a description of a small keyway cutting device, which is a very excellent little tool for cutting small flat-bottomed keyways, but for speed and sensitiveness it is far behind the one here described, which is designed for cutting small cotter holes through piston rods, pump spindles, valve stems, etc. It will not cut keyways, as the cutter works through a radius, as will be seen from the illustrations.

A is a gray-iron casting planed to fit the small bed *Z*; *B* is a machinery-steel forging bored and threaded to receive the two ball races *I* and *J*, for carrying the cutter spindle *E*. *C* and *D* are two set-screws, each carrying a ⅜-inch hard-steel ball *T*, in the end as shown, to support *B*, the latter having its two vertical arms recessed and case-hardened to receive the balls. *S* are the two lock nuts for securing the adjusting screws. *F* is the driving pulley keyed on to the spindle *E*. *G* is the threaded chuck for carrying the slot drill cutter *H*. *K* and *L* are two screws operating through the sides of the lugs surrounding the elongated hole cored in the front supporting arm of *A*, for adjusting the length of stroke in the cotter hole to be cut. This is effected by adjusting these two screws so as to allow the operating lever *O*, which is screwed into *B*, being oscillated through a larger or smaller arc as desired, and determines the length of cotter hole to be cut. *M* and *N* are the two lock nuts for securing

the stroke-adjusting screws *K* and *L*. *P* is a nut, cast solid with *A*, for the feed-operating screw, with the nurled hand wheel *Q*, to work through. *U* is a steel plate for securing the feed screw in position by the medium of four screws tapped into the holes marked *V* in the end of the bed *Z*. *R* are the ball-race locking screws.

To operate the machine, the hand lever *O* is moved through a radius up against the two set-screw ends *K* and *L*. The spindle, running on ball bearings, is extremely sensitive, and is run at a very high speed. The hand lever *O*, being screwed directly into head carrying the cutter spindle, no lost motion can possibly take place through the medium of levers, or loose joints, etc., as is possible on the one described on page 254.

We can cut cotter holes 3/16 inch wide by ¾ inch long with this machine, this being its maximum capacity, through a spindle ½ inch diameter, in 8 minutes. It is operated by a boy. It formerly took us 35 minutes to cut the same cotter hole on a much larger and more expensive machine operated by a man. We now have two of these machines in constant use.

WALTER CONRAD.

London, England.

Multiple Cutting-off Tool for Oil Rings

In a shop where a large number of oil rings were used it was found necessary to devise some means of cutting them off other than the slow and tedious method of using short lengths of tubing on a mandrel, chamfering the corners with an angular tool, and using a parting tool to separate them.

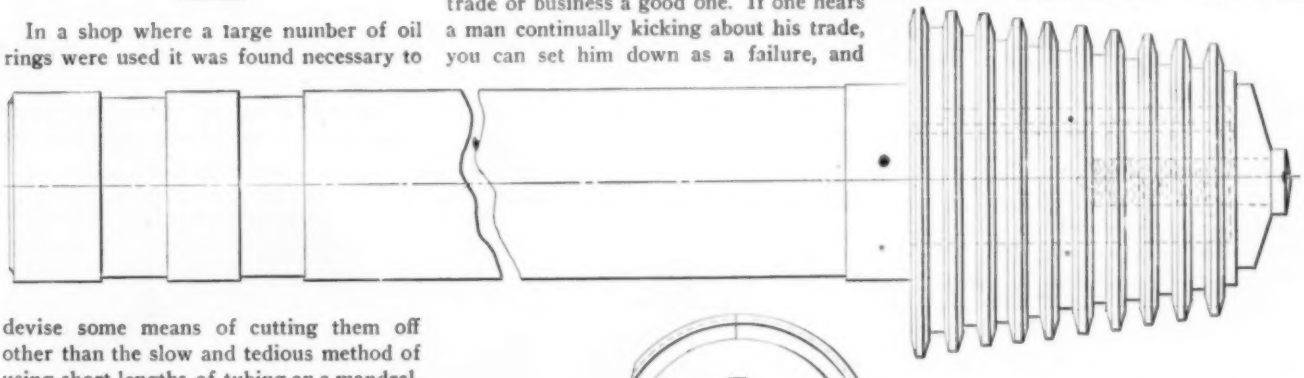
Not having an automatic machine at hand, the only place in which it could be done was on a Jones & Lamson flat turret lathe. So I made a bar and cutter as per sketch, the base of the tooth on one side of the cutter being lower than that on the other, and having the same diameter as that of the next smaller cutter on the bar; it will be seen that the ring was, of course, in shape just the reverse of that of the space between the two cutters.

The tool was set up and used in the following manner: The bar was made long enough to reach across the turret and turned to fit the tool block (1 9/16 in. in diameter) on the side furthest from the work, and clamped in position by the set-screws in the tool block, the screws setting into the two places turned in the bar for that purpose. The other end, next to the cutter, was supported by a split cast-iron bushing held in a larger tool block. In the end of the bushing I put a screw with a check nut to stop the work the right distance from the first or largest cutter.

This bar worked very well, with one exception, as was found on trying it. The ring, on being cut through, would cling to the tubing, turn over and gouge into the cutters (a fault that brass always has, but in this case was easily remedied). So I made a yoke to fit and clamp onto the bar back of the forward tool block, fastened a piece of 3/8-inch drill rod into it long enough to reach into the tubing; this was adjusted just high enough to clear the bottom of the inside of the tubing, and thus prevented the ring from jumping and gouging into the cutters.

This bar has worked very successfully, in so much that the production has increased from 700 to 3500 per day of 10 hours, and that bars were afterward made for all other sizes of oil rings.

W. F. MALO.



MULTIPLE CUTTING-OFF TOOL FOR OIL-RINGS

A Young Man's Opportunity in the Machine Shop

Almost without exception, unless a man is a rank failure, he considers his own trade or business a good one. If one hears a man continually kicking about his trade, you can set him down as a failure, and you will hit the truth so often that the misses do not count.

Naturally, having been brought up in the machine shop, I consider a young man's chances there for getting ahead as good, if not better, than in any other line. Of course the second and third rate and the unclassified men are in the great majority in this as in many other trades; but it is this very condition that carries the opportunities, and it is up to every young man who works in a shop to show whether he can make good or not. He'll get the chance. If he does not, and is of the right stuff, he will make the chance. It is all nonsense to say that a man has no show nowadays to get ahead in the machine shop, or that the bosses try to keep a man at one thing all the time and do not give him a chance to learn.

If a young man learns to run only one machine, it is his own fault. Many a man has studied out the mechanism of an unfamiliar machine in spare moments of the noon hour. "But," some say, "I must rest at noon." Remember, it is the "constitutionally tired" man who never gets ahead. In our shop, posted in every department, is the revised version of an old motto, reading: "All things come to those who hustle while they wait."

There are some things others cannot do for one, and a man must hustle for his own place; but he should never confuse a quick, alert, self-reliant attitude with careless, unthinking haste.

The young man who starts out "getting experience," as he calls it, by jumping from one shop to another and staying only a few weeks in a place, makes a big mistake. One cannot learn all there is to learn about a shop in a few weeks or even months. Again, an employer is always suspicious of a man who does not stick at least several years in a place. I do not mean that a man should necessarily stay in one shop, though there are shops in which one might spend a lifetime and learn all the time; but if a man is looking for a place as foreman or superintendent, and can show a record of having stayed from three to five years in two or three places, it counts immensely. In my own case, a record of five years with one of the largest firms in the United States has helped me more than anything else.

Not long ago a well-known firm was looking for a foundry foreman to take complete charge of all the output of their immense foundry. Among the applicants was an alert, business-like man, apparently about 35 years of age. The first question was: "Where have you worked?" The answer was: "Three years with the Atlas Iron Works and fourteen years with the Union Iron Works. I'm foreman there now." The manager held out his hand, with the exclamation: "You're the man I want!" And events have since

proved he was. Of course this was an exceptional record, and few men can show as good a one; but it shows what I want to impress. It doesn't pay to change too often, but it does pay to get a reputation for being steady and reliable, as well as ambitious and up to date.

A young man must learn thoroughly what he does learn. He should not only know how to do all the ordinary jobs on his machine, but he should try to figure out for himself how to do unusual ones, and not only to do them, but to tell others how, and tell them without a waste of words, and yet so plainly that he cannot be misunderstood. He should let his foreman see that he takes an interest in his work, by keeping his machine as clean and orderly as circumstances will allow.

Many a time, when I was a shop foreman, I have had the superintendent say to me, referring to some intelligent appearing fellow: "That's a bright, clean-looking chap; better let me have him for the experimental room." If the young man made good in his new place, he could thank his personal appearance for first attracting and affording him a chance.

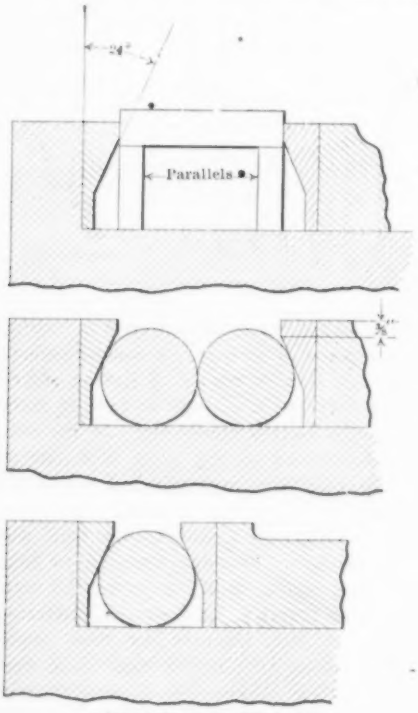
There are always opportunities turning up and a young man must fit himself to grasp them, or, in the words of our motto, "He must hustle while he waits."

ETHAN VIALL.

Jaws for Machine Vise

The machine-vise jaws shown in the sketches herewith, which we have found very useful in our shop, were first devised by our foreman for use in key-seating a lot of shafting so that we could hold two shafts at once without going to the expense of making special holding devices for them. We believe that these jaws are far better for a general-purpose vise than the ordinary jaw in use, planed square from the top to the bottom, as they hold any kind of round work far better than common jaws, always drawing it firmly to the bottom and insuring that the key-seat will be cut parallel with the shaft. For planing thin, flat work, it is, with them, easier to draw a job down on to parallels than with the common jaws; in fact, we have found no job where they do not give better results than the plain jaws.

W. P. HUNT.



JAWS FOR MACHINE VISE

Babbitting Fixtures

On pages 552 and 553 is an article on babbitting, by Chas. P. Fuller. Is it supposed that the sides of the holes to be babbitted are machined, or are they rough? If machined, well and good; but if rough, then I would expect no end of trouble on account of the keys which hold up the collars. In my 25 years' experience I have seen very few rough surfaces where this method could be used, on account of their irregularity.

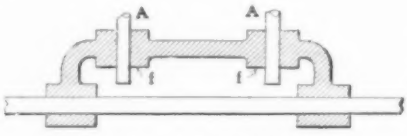


FIG. 1. PIECE TO BE BABBITTED

At my present place of employment we babbbitt, on some days, two to three hundred bearings of various sizes, 1¼x4 inches to 6x20 inches, but we clay them all. I would be only too glad to adopt anything better than this, on account of the mess it makes.

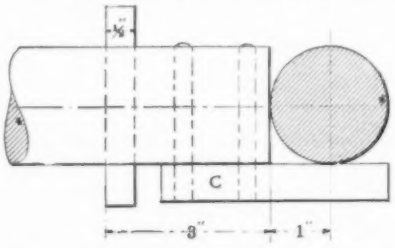


FIG. 2. PLUG FOR LOCATING A BABBITTING ARBOR

Recently we had some babbitting to do on a job which required shafts to be at right angles as shown by Fig. 1. The two bearings *A A* had been bored and faced where marked *f*. The other two required babbitting.

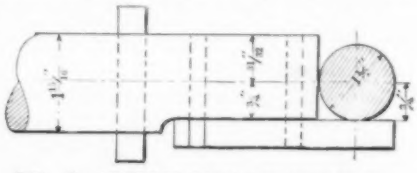


FIG. 3. ANOTHER PLUG FOR LOCATING A BABBITTING ARBOR

This little job was easily and quickly done by making two plugs of cold-rolled steel of the same size as the shafts at *A A*. Holes were drilled through them for ½-inch pins, as shown by Fig. 2. These plugs located the shaft which was to be babbitted at right angles with the others, and at the same time held it at the proper distance from the faces *f f*. The small cleat *C* held the shaft horizontal.

In this case both shafts were of the same diameter. Later we had some pieces where the shafts varied; the two at *A A* were 1 15/16 inches, the other 1½ inches. Here we made the plugs as shown by Fig. 3. It needs no explanation.

A. MERTES.

A Use for Tracing Cloth

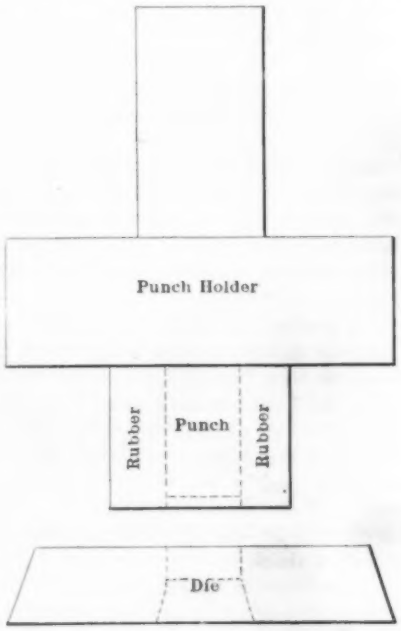
It is perhaps not generally known among draftsmen that tracing cloth makes an excellent shade for the windows on the sunny side of the drafting room. It is not nearly as opaque as the ordinary roller-shade fabric and therefore admits much more light. The strongest sunlight is softened and diffused for working.

If incandescent electric lamps are used for artificial light, scraps of tracing cloth may be utilized as shades for these, giving about the same lighting effect as with frosted-glass globes. As tracing cloth is always on hand among the drafting-room supplies, it is convenient to use where the blinding sunlight is to be avoided.

E. J. BARTLETT.

A Punch with a Rubber Stripper

I have had many a job on the punch press where I would have the die, but it might be a combination die, and I would only want to use one part of it. Well, the stripper on the die would be of no use to me for that job, so I would have



A DIE WITH A RUBBER STRIPPER

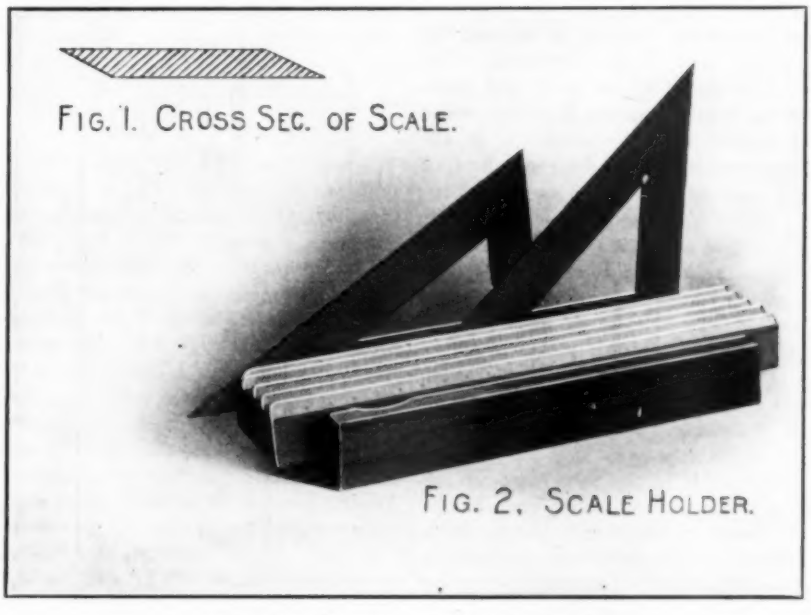
to pry the scrap off the punch, and it would take a long time. The other day it came to me to take a piece of rubber and let the punch go through the rubber, remaining on the punch and projecting below it about ¼ of an inch, so when I punched one the rubber would push the scrap off the punch. I made 1000 blanks with it, and it worked finely. The blank was 1 inch diameter and 1/64 inch thick. Thinking it is a new kink, I send it to you with sketch. H. G. BENTLEY.

Improving the Draftsman's Scale

Regarding H. E. Seaver's method of improving scales, at page 637, while the device has some merit, it is after all only a way of making a poor thing a little better. A flat scale has no business to be made as shown in his cut, although I know that all instrument-makers make their scales in this way, for the scales lie flat on the paper, and you can't get hold of them. A much better way of making scales is to have both edges beveled opposite, as shown in Fig. 1. A scale made in this way is very easy to handle and can be readily picked up. Only one set of figures appears on a side, and there is no confusion resulting from the eye having to distinguish between the two sets, as when the figures are all on one side.

The graduations should be cut the entire length, so that it is not necessary to do all the work with one end. By this method, a draftsman can work from either end or from the middle each way, and a great deal of time is saved by doing away with the dividers to set off the measurements. These scales were made with celluloid faces on the beveled edges, which are much easier to read and keep clean than the ordinary boxwood. Only two graduations were on each scale, arranged in pairs, thus: Full size and half size, 3 inches and 1½ inches to the foot; 1 inch and ½ inch to the foot, ¾ and ⅜ inch; ¼ and ⅛ inch. This is a better arrangement than mixing the scales up, as the graduations on each scale are in the same fractional divisions.

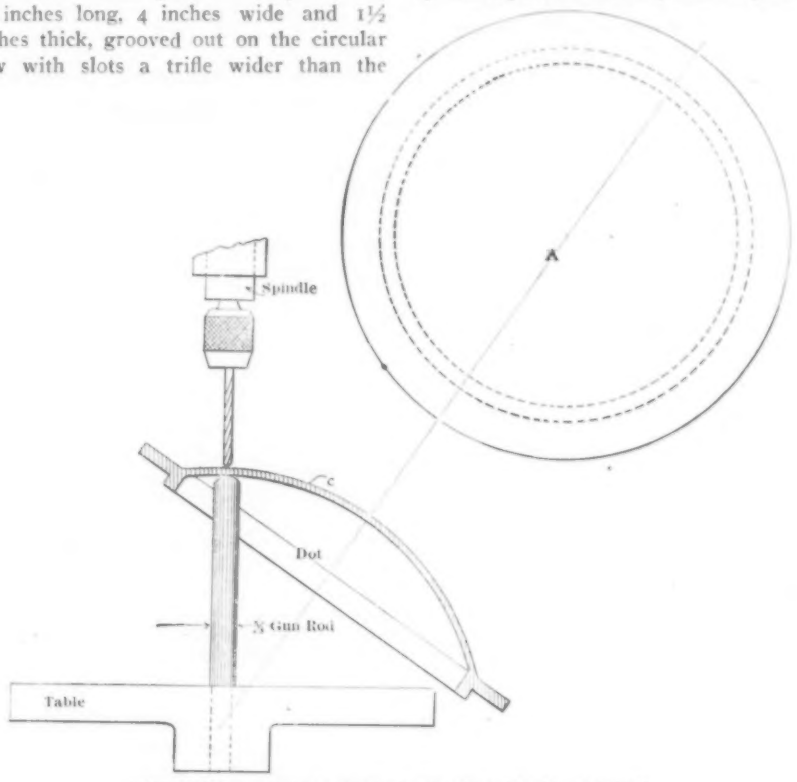
While on the subject of scales Fig. 2 illustrates a convenient scale holder. This is made of a small piece of soft pine about 10 inches long, 4 inches wide and 1½ inches thick, grooved out on the circular saw with slots a trifle wider than the thickness of the scales. It can be located at any convenient point on the desk or wall, and makes a neat and safe place to keep the scales when not in use. The edges are protected, and as any scale is wanted it can be readily taken from the rack. W. C. MCLEOD.



DRAFTSMAN'S SCALE AND SCALE HOLDER

Finishing a Spherical Surface on a Brass Pattern

The illustration shows a job in brass-pattern work. This scheme is often used by wood-pattern makers, and may be of interest to some of the readers of the AMERICAN MACHINIST.



FINISHING A SPHERICAL SURFACE ON A BRASS PATTERN

The piece *A*, of which a sectional view is shown in the drill press, is a brass pattern 8 inches in its largest diameter, and finished all over. The thickness of the spherical portion *C* is made ⅛ inch, which is about as small a space as the cast-iron metal will run in, considering the diameter of the piece.

The inner part of *A* is finished by a sweep, using the compound rest of the lathe with the tool set at the required radius. The pattern is then taken to a small drill press and with the spindle stop set so that the distance between the point of the drill and the ⅝-inch temporary gun-rod spindle equals ⅛ inch, a row of holes, very close together, is drilled with a small drill, from one side of the pattern to the center. The pattern is then returned to the lathe, roughed down with a brass tool and finished with a hand tool. Work of this description should first have enough metal roughed off from all parts before any attempt is made at finishing, so as to relieve any strains that may be on the metal.

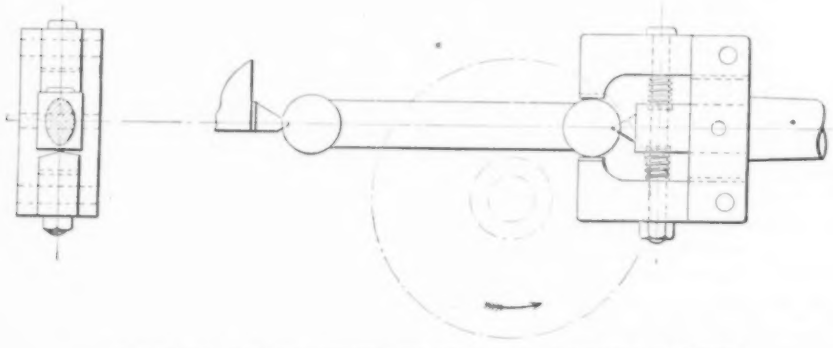
GEORGE A. MARCH.

Milling Connecting-rod Ends

The connecting-rods were steel castings, and the sizes ranged from 5¾ inches to 12 inches center distance, and the diameters of the ends from 1 to 1½ inches. My first idea was to center each end and hold them between centers, then mill one end with a pair of straddle mills, holding the other end with a dog and then turn the connecting-rod around to mill the other end, but I found this to be a very slow operation as the finished end had to be squared up to get both ends in line.

I then designed the chuck shown in the illustration, which enabled me to finish both ends in one setting by reversing the feed of the milling machine. Of course, on the shorter ones I had to use the vertical feed for the one end, owing to the fact that I had to use cutters 6 inches in diameter. In conclusion I wish to say that a green boy finished several hundred that way without the least variation.

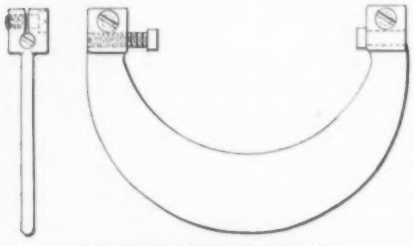
CINCINNATUS.



CHUCK FOR HOLDING CONNECTING RODS IN THE MILLING MACHINE

An Adjustable Snap Gage

I notice on page 711 that Gage complains of having a good deal of trouble with his snap gages. The accompanying cut shows an adjustable snap gage which is used successfully in our grinding department. The frame is cast steel and the anvils are of tool steel, hardened and ground. The gages are made in sizes of ½ inch from 1 to 6 inches.



AN ADJUSTABLE SNAP GAGE

We have a great variety of external grinding to do, and the most of it is a few thousandths more or less than even sixty-fourths. We find that we save a great deal of time and trouble in using a gage of this kind.

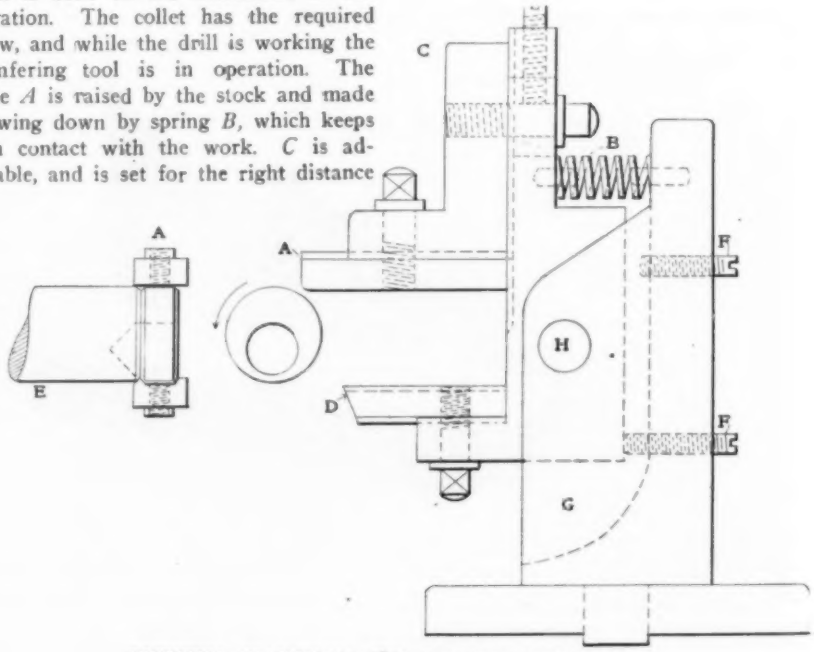
For most of the parts we have samples to work to and the gages are set to the sample. If no sample is at hand, the first piece is ground to a micrometer measurement and the gage set from that piece. In this way we save micrometers and at the same time do not have to have a separate snap gage for each job. While this gage is by no means fool-proof, it may help our friend a little.

HENNING.

Eccentric Chamfering Tool for the Automatic

The sketch shows a toolholder for chamfering work on the automatic which is similar to one made by the National Acme Company for a shaving tool. The piece it is used on is an eccentric collar, and has to be chamfered on both edges. Formerly the edges were chamfered on a hand machine. By means of this tool the work is done on the automatics in one operation. The collet has the required throw, and while the drill is working the chamfering tool is in operation. The guide *A* is raised by the stock and made to swing down by spring *B*, which keeps it in contact with the work. *C* is adjustable, and is set for the right distance from cutter *D*, which is about ¼ inch shorter than *A*. No doubt it would be more convenient to have the part where *D* is fastened made adjustable also. *E* shows the stock with the tool and guide in position. Screws *F* are stops. The block is milled out at *G* ½ inch wide for the pivoted holder to swing in, this part being held on pin *H*. The tool cuts underneath and looks rather odd while in operation.

McK.



ECCENTRIC CHAMFERING TOOL FOR THE AUTOMATIC

Testing Hardness of Metals and Materials

The impact-testing tool of W. I. Ballentine, described at page 698, will no doubt prove useful for determining the relative ease with which rivets can be headed, but fails to fulfil a single requirement of a tool for testing the abrasive effect of material on a cutting tool. In a recent magazine article it is stated that the invariable maxim of Thomas A. Edison has been: "If it can be done—is it worth anything?" As I followed the reasoning in the description of this tool I was forced to conclude that it was worth nothing for the purpose specified.

Mr. Ballentine's first postulate is: "A thorough knowledge of the physical properties of the material being worked and their effect upon reduction by the new steels."

We will therefore assume that the tool shown is for the purpose of ascertaining "their effect upon reduction by the new steels." Now does it show anything of the kind and does the resistance of a body to penetration have anything to do with its effect upon a cutting tool? Any man who has turned large lead laps to any extent will say that it is harder to keep an edge on a tool against lead than against tool steel. Manganese-steel castings, as used in the shop Mr. Ballentine refers to, resist the action of a cutting

tool to such an extent that it is impossible to machine them; yet they offer little resistance to impact, and a manganese-steel rivet can easily be headed cold. Aluminum resists a tool to a marked degree; yet I think lead, aluminum and manganese steel would all register softer than the cast-iron wedge shown, if this was a true test.

It seems to me that the final assumption, viz.: "Therefore the recording disk offering a constant resistance to penetration will be penetrated to varying depths, as the resistance of the materials being tested to penetration varies, or the penetration of the recording disk would vary as the hardness of the metal under test varies"—is all wrong as worded, and should end up by saying: . . . as the resistance to impact of the metal under test varies.

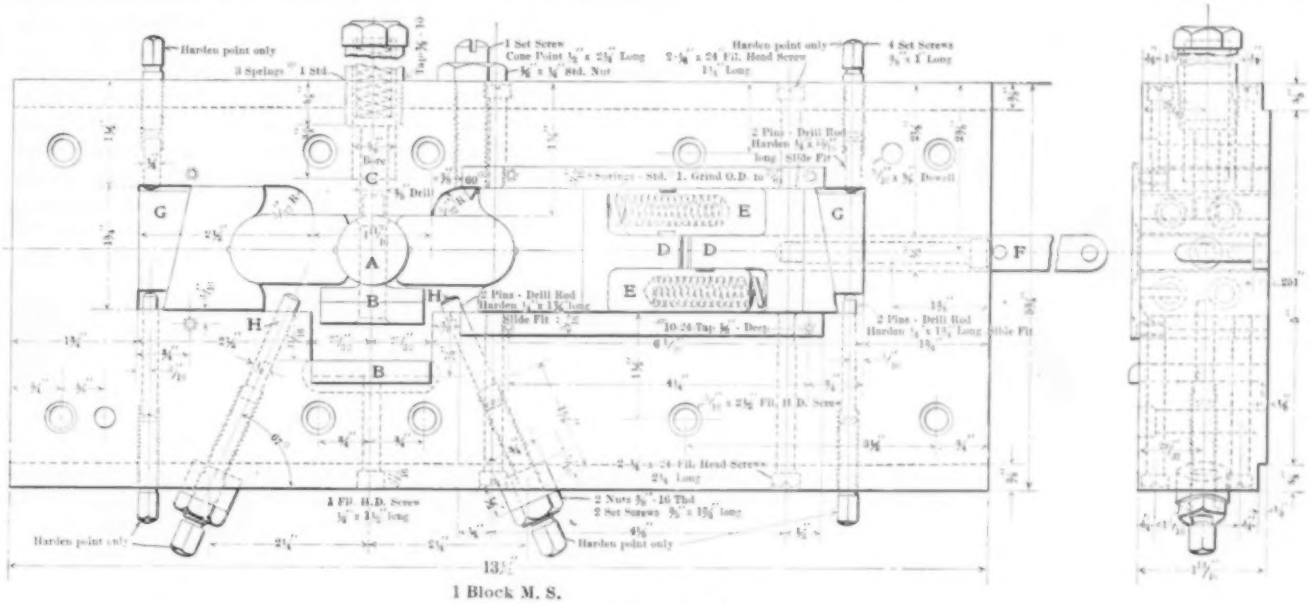
Things equal to the same thing are equal to each other, but nothing is advanced to show that "hardness" and "resistance to impact" are equal to the same thing. I incline to the belief that cork would show hard on such a test, and while I might be able to jump off a barrel and measure the imprint on the ground to establish data from which to measure the rate at which my shoes would wear out, I fear the argument would carry little conviction to others. A circular level in the tool would surely allow it to be plumbed, but how about the piece to be tested? Should not the surface to be tested be leveled and scraped to a bearing or surface ground to insure a perfectly square blow?

When I look at the tabulated results on page 699, carried out to five decimal places, I wonder if the author smokes the same tobacco I do, and whether he knows what a hundred-thousandth of an inch really looks like. When you want to test cutting qualities why not make a cutting test, and for this purpose, in what particular way does the hardness testing machine of W. J. Keep fall down? It is true, the test bar may vary some, but is the casting the same at all points, and are there no hard spots, and how about scale? Will impact upon scale tell anything about what is under it?

LUCIEN I. YEOMANS.

A Swaging Die

Some time ago it was put up to us by the shop to design a swaging die for upsetting the end of a small steel piece. The die then in use for this operation was giving considerable trouble, and as a large number of the parts are constantly required, a die was needed which would be as nearly automatic as possible, and present as well the good points of durability and ease of adjustment.



1 Block M. S.

A SWAGING DIE

The drawing herewith shows two views of the die we finally decided upon for this work, in the elevation there being shown a plate used to cover the working parts and retain them in position, the plan view showing the plate removed in order to represent the parts more clearly.

The pressure required for clamping the piece while the upsetting was being done being necessarily great, a toggle motion was utilized; its center member is shown at *A* in the plan view, with the two links on the right and left of this piece bearing at their outer ends against two tool-steel blocks, which are recessed to fit snugly; all are hardened and ground to accurate dimensions. The toggle mechanism is actuated by a plunger moving up and down with the ram of the press, and bearing against the blocks *B B;* it is released when the plunger is out of the way by the pressure of the horizontal spring plunger *C* on the opposite side.

It was found that the jaws *D D* themselves would sometimes stick together after a piece had been swaged, and to obviate this nuisance blocks *E E* were made, each drilled with two holes and fitted with springs, thus keeping the alinement of the jaws correct and forcing them apart when the toggle pressure was not upon them. A movement of the slide *F* permitted the piece to drop through of itself, and a new one could be inserted and retained in a correct position after the slide was returned to the stop.

Lateral adjustment is obtained through the screws bearing upon the pieces *G G*, adjustment at both ends being provided to keep the alinement of the toggle mechanism correct. The stops *H H* are for limiting the releasing motion of the toggle and can also be adjusted to suit the work. The screw cap *J* is to retain the spring actuating the horizontal plunger.

The die has proved very successful and could be used for the swaging of any similar piece without any change being necessary except in the jaws.

G. VAN HAMKAR.

Cutting Triple Threads

Some time ago we got some screws in our shop to cut which were about 18 inches long, 1⅜ inches diameter, 1½ inches lead and ½ inch pitch with triple square threads; they were taken in hand by a machinist and he proceeded to cut them in the good old way, that is, by putting a wheel on the leading screw that would divide by 3, and then roughing out one thread, throwing the quadrant out of gear and putting the gear wheel a third round, roughing out the second thread and then doing the same for the third. As is usual, the job sprung and the tool dug and jarred when the groove was getting deep enough, and a good deal of guess-work went on as the depth could not be cali-

pered. Some time afterward a second lot came in and they were brought to my lathe, a 24-inch Pond tool. I thought I would make the job worthy of the machine, and after a little thinking I decided to proceed as follows:

The lead was 1½ inches, the lead screw was ½ inch pitch or a ratio of 3 turns to one of screw to be cut. After putting on the change gears, I got the saddle back and the nut closed; then I marked the lead screw and bracket and the face plate and headstock as though for cutting an odd pitch; in addition I put a big 1 against the mark on the face plate, opened the nut and pulled the face plate one-third round and dropped the nut in again, the lead screw of course being in its first position. I put a second mark on face plate by the side of mark on headstock and this time put a large 2 on the face plate, opened the nut again, gave the face plate another third of a revolution and brought the guide chalk mark on top again and marked the plate with a 3, so that the plate was roughly divided into three divisions 120 degrees each and as each number passed the mark on the headstock the lead screw was in the right position for taking the nut. The chalk mark on the lead screw was no use now as it only served as a guide while dividing the plate, and the nut, if dropped when either of the numbers on the plate was passing the headstock line, could not help finding its correct position. I then set the cross-traverse stop to prevent going too deep with the tool. After setting the cut and starting the lathe, the nut was dropped in as 1 passed, the carriage was then run back and the nut dropped in as 2 passed and then again as 3 passed with the same depth of cut. Each cut was then increased and each groove followed up as they came round, so that the metal was removed uniformly instead of taking one groove nearly down to size before reaching another; also the bottom of the thread diameter could be measured. The process was exactly like cutting a single thread, only the work required catching at 3 points. This allowed the screw to be finished easily, as all threads were alike.

The method may be applied to any screw whose threads are a multiple of the lead screw, as in this case.

J. WATSON.

Turning Rubber and Felt Rolls

After reading Walter Gribben's article, on page 17, about turning soft rubber rolls, I thought the methods used in our shop might be of interest. We make and repair numbers of rolls, covered with felt, that are used on shoe machinery. A roll is put on an arbor in a speed lathe. We have a bed *A* in Fig. 1, made of wood, which fits over the ways. It has an iron plate *B*, hinged at the back, and the plate is raised and lowered by screw *C*. By using coarse sandpaper a roll is quickly roughed down and is then finished with fine paper.

Sometimes we have special rolls so large that we cannot use Fig. 1. Then we use a piece of board and hold the sandpaper against that. One end of the board rests on the bed of the lathe, Fig. 2, and

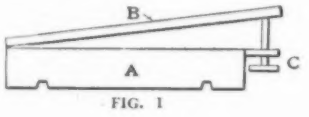


FIG. 1

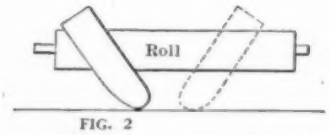


FIG. 2

TURNING RUBBER AND FELT ROLLS

the board is rocked from one end of the roll to the other. The end of the board that rests on the lathe will work more easily if it is rounded, but that is not necessary. The rolls are very rough and uneven at first, but can be taken down with the board so that when a pencil is held against it the lead mark shows clearly all around. There is danger of not getting it the same diameter the whole length unless care is used. I think the same method could be used on rubber, as we have narrow rubber wheels about 4 inches in diameter and 1 inch wide that we true up with a stick and fine sandpaper. Large felt wheels about 2 inches wide and 8 inches diameter are trued up in the same manner, but it takes practice to finish them up so that there will be no jump in them.

B. H. WOOD.

Adjustable Supports for Milling Fixtures

The description of adjustable stops for a milling fixture, described in the AMERICAN MACHINIST, at page 743, Vol. 30, Part 1, interests me a good deal for the reason that I have just designed two fixtures for precisely the same type of work. The castings to be machined are in essential points similar to the one described in the article referred to, and are held in the fixtures on three fixed points by means of clamps on small projections cast on the outer edge. The object in providing these was to place the clamps entirely clear of the surfaces to be machined, the frame being of such a shape that this was imperative. These projections or lugs were, of course, broken off afterward.

In addition to the clamps on the three

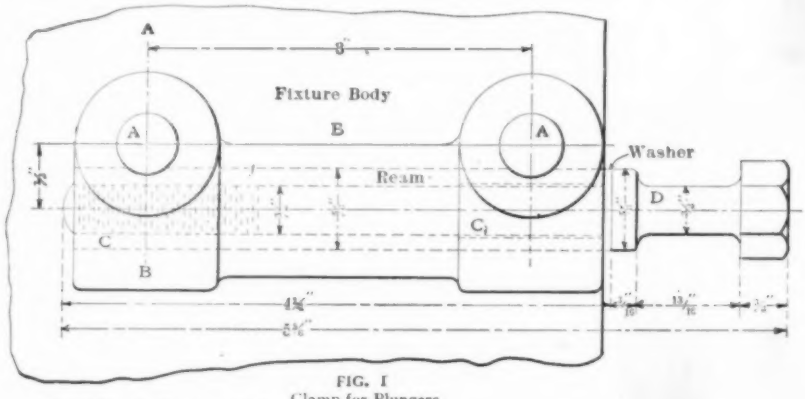


FIG. 1
Clamp for Plungers

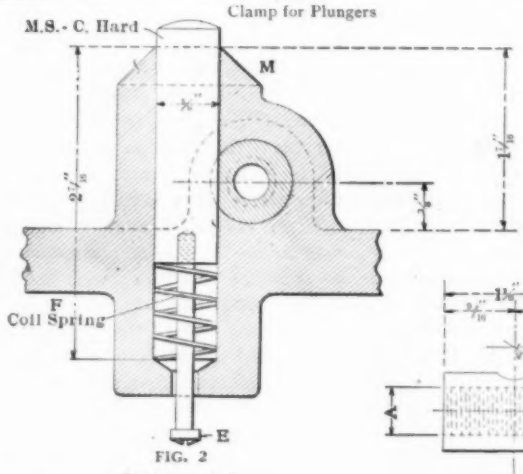


FIG. 2
Section on A-B

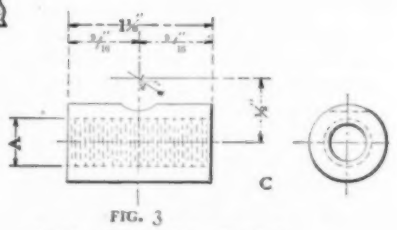


FIG. 3

Locking Sleeve - M.S. - C. Hard
1 Wanted with "A" - ⅝" - 16 Th'ds Tap
1 " " "A" - 29/64" Drill

ADJUSTABLE SUPPORTS FOR MILLING FIXTURES

fixed points, a fourth adjustable, or floating, clamp was provided, and ten adjustable supports arranged in suitable positions under the different bosses. An ingenious feature of the three clamps over the fixed points was that all three were tightened on the work simultaneously and by one screw, thus eliminating the chances of distortion by tightening individually, and reducing the time required to operate. In designing the adjustable supports it was endeavored to arrange them so as to be clamped in pairs. This was accomplished in two ways, both of which proved thoroughly efficient.

On reference to the sketch Fig. 1, *A A* are the adjustable plungers, *B* the fixture body; *C C* are two sleeves shown in detail, one tapped, and the other drilled with clearance for the screw *D*. It will readily be seen that on turning *D* the two sleeves are drawn together and clamp the plungers *A A* without any tendency to either raise or lower them. A similar construction to this is a familiar one in many screw-machine turrets. Fig. 2 is a section on *A B*, the screw *E* preventing the plunger from being forced out by spring *F*. Six plungers were clamped in this manner, but the other four were so awkwardly placed in relation to one another that a different scheme was used.

In Fig. 4, *G G* are the plungers shown in detail at *H*, and *J J* are two hardened pins ground at an angle on the ends to suit the flats on the plungers, and expanded against them by means of the wedge-ended pin *K*, actuated by the screw *L*. In this case the screws retaining the plungers are not needed, the pins *J J* being sufficient to prevent them from coming out. Of course the clamp screw *L* need not be placed midway between the plungers, this being arranged to suit other conditions in the fixture.

An important feature in the construction of supports of this character is the chamfered corner at *M* to prevent chips accumulating and causing inconvenience.

To obtain the best results, all plungers, pins, screws and sleeves should be hardened, and if properly fitted they will work without any trouble. S. W. MILLS.

Something New in the Measurement of Power

Referring to page 1, "Something New in the Measurement of Power," the idea is quite a novel one, but it is not clear to me how the dynamo takes care of the weighing lever when changed from a motor to a generator or *vice versa*. If arranged to act as a generator, then when used as a motor the lever will tend to rise. When intended to be used both as a motor and generator it looks to me as though two levers and two scales would be necessary if the machine is not to be stopped between weighings.

H. G. STONER.

Submitting this to Mr. Souther he replies as follows:

We did provide two levers on the generator, one of which is used to measure the torque when the electric generator is being driven by the gasolene motor. This one we have used continuously, of course.

The arm on the other side we have never used, not feeling the need of it, but it could be quickly equipped if needed.

HENRY SOUTHER.

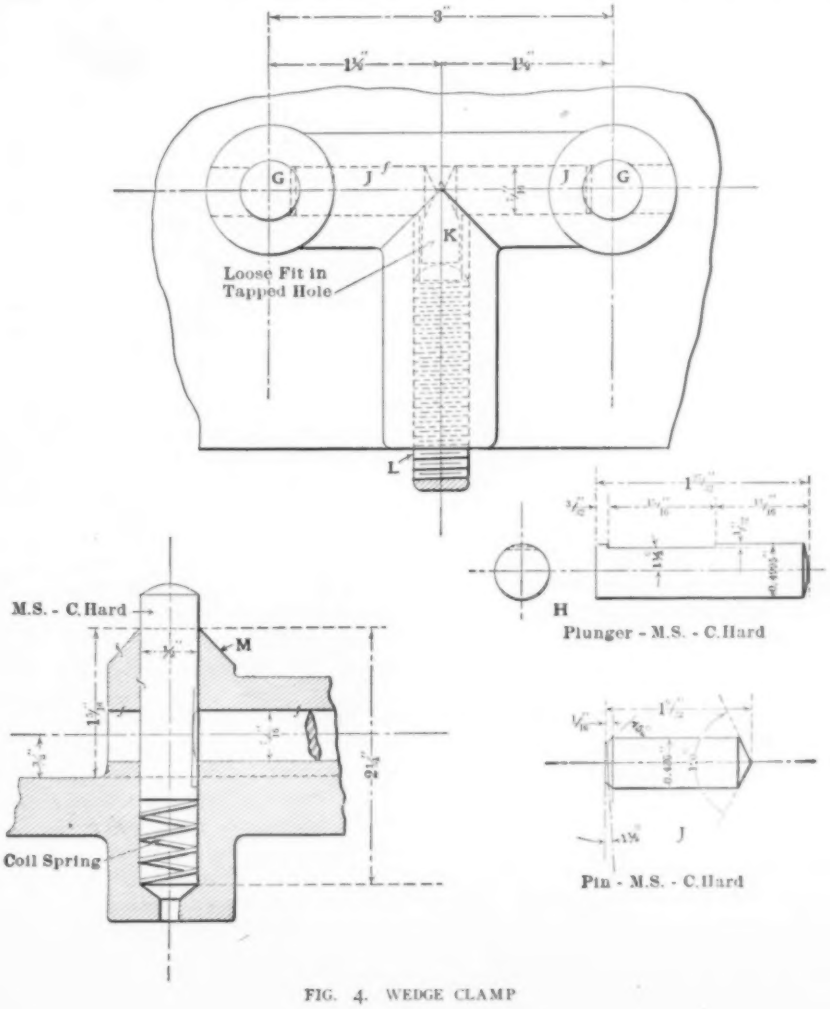
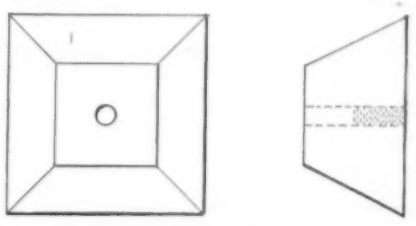


FIG. 4. WEDGE CLAMP

A Cheap Shop Fan

I would suggest that the shop fan shown by A. B., at page 923, would be better and more efficient if the center block



CENTER BLOCK FOR CHEAP FAN

were made as in the sketch with this article. This block would also be easier to make than the other.

A. G. KNIGHT.

We hear that the Admiralty have issued instructions that the premium system of piecework having produced satisfactory results, is to be retained. The time-setters at present receive 9s. per week additional pay to their mechanics' wages. These are to be retained at their present rate of pay, but should any be appointed in future they are to be paid the same wages and serve under the same conditions as a recorder of work.

The divining-rod expert who was sent by the German authorities to their colony in Southwest Africa has been unsuccessful in his attempts to find water. This expert made many discoveries of underground water supplies in Germany, and the home government accordingly determined to utilize his services in the colony, where the need of water is pressing. It was stated that he was successful in but one place, a valley where a chalk formation contained a great deal of water and wells would have been successful if driven anywhere. In other places his predictions that water would be found at depths of 90 to 215 ft. proved entirely unsuccessful, as the borings were carried down much below the predicted depth of the water-bearing stratum, but were entirely dry.—*The Engineering Record.*

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The Semi-annual Index

The index of Part 1, Vol. 30, is now ready and has been mailed to all subscribers who receive their papers direct from this office. All other readers who wish a copy can obtain it free by sending a postal-card request. Our index is very thoroughly made, and in it we take great pride. Every reader should have a copy.

The Industrial Development of the South

In a recently published pamphlet entitled "Facts about the South," by Richard H. Edmonds of the *Manufacturers' Record*, of Baltimore, there is much material worthy of the consideration of everyone interested in the development of our national resources and industries. The author presents a wealth of information relative to the progress made by the South in recent years in agriculture, mining, manufactures, transportation facilities, etc. He tells of the extensive development of hitherto unutilized water powers for the generation of electricity; describes the diversity of industries as now carried on; and in short brings out a store of facts and figures covering the lines and extent of Southern industrial and commercial expansion.

In the past decade the capital invested in the cotton mills of the South increased from $92,000,000 to $250,000,000, the number of spindles being increased nearly threefold. Fifteen thousand nine hundred miles of railroad were built during that period, and exports from Southern ports to foreign countries amounted to $4,978,000,000. It is stated in the pamphlet from which these particulars are derived, that while 10 years ago it was still doubtful as to whether the South could compete with New England in the manufacture of cotton goods, it is now a question whether New England can compete with the South in this line. Similarly in regard to iron and steel matters, it is stated that it is no longer a question whether Alabama can compete with Pennsylvania, but it is already foreseen that the time is approaching when it will be a question whether Pennsylvania can compete with Alabama.

Shortly before his death, Abram S. Hewitt, in a statement prepared on the world's iron industry, said:

"The supremacy has been permanently established in this country, and this means in the not very distant future the supremacy in shipbuilding and in all the interests based on coal and iron and steel. Its worldwide effect, its influence upon trade and transportation, upon the commerce and the finances of the world, are beyond our power at present to fully grasp. The two centers for dominating the iron and steel of the world are to be the Lake Superior region, with its bessemer ores, on one side, and Alabama, with its basic ores, on the other. The growth of the basic-steel industry, now that it has been fairly started in the South, ought to be very rapid. That section, with its abundant stores of ore and coal and limestone in such close proximity as is found in Alabama, bids fair within the next quarter of a century to dominate the basic-steel industry of the world."

It is interesting to note that this prediction as to the South's position in the iron and steel world is nearing fulfilment. We quote from the pamphlet before us:

"At the beginning of this decade steel making in the South had not been proven a success. It is now admitted that Birmingham steel rails are the best made in America and the Bessemer process, which so long gave to the Northern steel interests a supremacy over the South, is now being fast superseded in this country, in Germany and in England by the basic progress, which has given Birmingham its preëminent quality of steel, and for which the vast stores of ore in the South are adapted. It has been proved that this section, which did not have a steel industry 10 years ago, and whose iron interests were feeble and lacking capital, can assemble the raw materials at a cost which will enable it to produce iron and steel at $2 to $3 a ton cheaper than any other part of the world. The destiny of the South as one of the world's greatest centers in iron and steel, and all the finished products of these industries has been settled."

In 1897 the pig-iron production of the South was 1,913,346 tons. By 1906 the production had increased to 3,467,216 tons, the increase for the decade over the 10 years preceding being 84 per cent. It is estimated that in 1916 the output will be 7,500,000 tons. It is a generally accepted fact that the South has at least one-half of the known iron ores of this country. It has with its 62,900 square miles of coal fields five times the coal area of Great Britain, and 25 per cent. more than all Europe; and these coal fields, like the iron-ore areas, are so situated as to be readily developed.

Naturally much attention is given by the author of this collection of facts about the South to the importance of the cotton crop, and statistics are presented by him comparing the production of this staple during the past few years with the years preceding. Thus the increase in production for the 10-year period just past is shown to be 42.7 per cent. over that for the preceding decade, the aggregate value of the crop for the last 10 years being over $4,600,000,000, a gain of 39.1 per cent. over the preceding 10 years. Similarly, particulars are presented of the value of cotton exports, and a striking comparison is made between the value of the cotton crop for the past six years, and the world's gold and silver output for the

same period. The figures presented show that if Europe during the period mentioned could have sent to the South every dollar of gold produced in the mines of the world, it would still have lacked $200,000,000 of paying its debt to that section for raw cotton.

The growth of general agriculture, livestock raising, lumbering, petroleum and mineral production, etc., the increase in value of farm properties, and in the capital invested in various lines of manufacture, are all subjects discussed by Mr. Edmonds in an instructive manner. He says in regard to the diversification of industry, that of the 339 separate kinds of industries within the scope of the census of manufactures of 1905, 262 are represented in the 14 Southern States; the extent of these industries is indicated by a comprehensive table covering some 50 different lines and revealing some interesting figures regarding the value of products. Lack of space, however, prevents us from entering into a discussion of these in detail at this time.

Reference has already been made to the hydro-electric work going on in the South, where over 500,000 horse-power is now under development at a cost bordering on $50,000,000. Mr. Edmonds states that Chattanooga interests are investing upward of $5,000,000 in harnessing the Tennessee river near that city, and other millions are being invested in developing the water power of the Chattahoochee, at Columbus, Ga. An aggregate of 100,000 horse-power is being developed near Atlanta, and another 100,000 horse-power at Muscle Shoals, in the Tennessee river, in Alabama. On the Yadkin river 70,000 horse-power is under development and plans for extensive operations in the upper Savannah, and at other points, are now being formed. The power thus made available will, of course, make possible a still further development of the industries of the South.

Engineering and a Code of Ethics

Electrical engineering having risen to the dignity of a profession, its practitioners, through the work of a special committee of the American Institute of Electrical Engineers, have imitated the action of the doctors and the lawyers by formulating a code of ethics to regulate the relations of electrical engineers with their fellows, with the manufacturers of electrical apparatus and with the public—this proposed code having been submitted at the recent Niagara Falls meeting of the institute.

We would be the last to deny that engineering is a profession. In the rigor of its training, and its intellectual character as a calling, it is second to none and that it is entitled to be called a profession cannot be denied. There is, however, a sharp difference between it and the professions of law and medicine, which in our opinion must largely vitiate any attempt to form a code of ethics on the lines of those which prevail in the medical and legal professions.

The name applied by lawyers to those who employ their services, is, quite properly, that of client, whereas this word, especially in this country, can only be applied in a small minority of cases in connection with engineering work.

The consulting engineer, properly so called, is fairly entitled to use this term, but, except in civil engineering, the consulting engineer is, in this country, at least, a small and diminishing party among his fellows. The difference is, perhaps, best seen by contrasting the ambitions of medical and legal students on the one hand with those of engineering students on the other. The former look forward to the opening of an office under their own name, where they shall meet and transact business with any who come to them, whereas the latter look forward to obtaining employment by a manufacturer, the opening of a consulting office being comparatively rare and usually determined by circumstances rather than by deliberate intention. That is to say, while physicians and lawyers deal with the general public, engineers commonly deal with one party—their employer.

An employee, regardless of his line of activities and of any high-sounding title by which he may designate himself, is the servant of his employer, and no code of ethics can be enforced which conflicts with the will of the employer. The employee does what the employer desires, or he loses his position, and it is idle to talk of engineers as a body laying down the terms upon which they will accept positions or rules which shall regulate the relations existing between themselves and their employers.

Looking at the matter in this light, it is obvious that those portions of the proposed code which relate to engineers employed by others, that is to most engineers, are unworkable. Thus we find "He should not take a position left by another electrical engineer without satisfying himself that the former has left it voluntarily or for proper reasons." It is not to be believed for a moment that any electrical manufacturing company will ever find the slightest difficulty in filling a vacant position because of this provision, nor is it to be believed that an engineer in want of a position would allow such a provision of the code to stand in the way of his accepting one which is satisfactory to him. Again we read "An electrical engineer in responsible charge of work should not permit other engineers, or non-technical persons, to over-rule his electrical engineering decisions. If this is done and persisted in he should, as soon as is practicable, withdraw." The employer is the final judge of the manner in which his money shall be spent. He is usually more or less of an engineer himself, and frequently a very competent one. The over-ruling of the decisions of engineers by their employers is the commonest of occurrences, and we believe this provision, or any other like it, to be absolutely unworkable.

The entire report betrays a sense of confusion among the committee. Looking upon engineering as a profession, they have thought to do as other professions do—ignoring, however, the fundamental difference in the status which exists between the members of various professions, and those whose money is exchanged for their work. They have forgotten that while lawyers work for clients, engineers work for employers, and that while the former may dictate the terms on which they will give their services, the latter cannot. In former days the status of the engineer, who was then a civil engineer, was more closely parallel with that of physicians and lawyers than at present, and in those days, and to a certain extent still, the civil engineer might fairly lay down a code of ethics. The mechanical engineer and electrical engineer are, however, and to an increasing degree, essentially employees, and we believe that any attempt to lay down a comprehensive code of ethics to apply to those professions must be abortive.

The code was referred back to the committee and the opposition to it, or, indeed, to any code, is such as to make it doubtful if the movement results in the adoption of it or any substitute.

It has been said that "if the whole of the power from Niagara was utilized, it would only give three times the horsepower that is thrown away by the blast furnaces of the United States of America alone."

The first Italian single-phase alternating electric current traction line was a small railroad at the Milan Exposition. One is now to be built in the Brembo Valley, in Lombardy, with a length of 30 kilometers. The power station, situated on the Brembo, contains 3 generators of 500 kilovoltamperes each, driven by horizontal-axis turbines at 500 revolutions per minute, and furnishing current at 6000 volts, 25 cycles. The current is conveyed to the locomotives by overhead wire, supported by catenary construction, and the return is through the rails. The locomotive, the weight of which is 36 metric tons, is mounted on two 4-wheeled trucks, and the body contains a postal compartment. It is furnished with four motors of 75 horse-power, which take current at 250 volts, the potential being stepped down by a transformer on the locomotive. The machine is designed to haul a train of 90 metric tons' weight at a maximum speed of 60 kilometers per hour, and a 120-ton train at 18 kilometers per hour on a 2 per cent. grade.

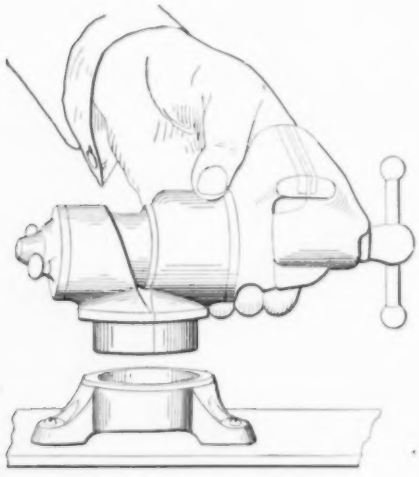
New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

A Handy Portable Vise

The ability to hold a piece of work firmly lightens the labor on any repair job, and this is particularly true of motor-boat and automobile repairs.



A HANDY PORTABLE VISE

To meet this requirement for a vise that shall be light enough to be easily portable, strong and rigid enough to be of real service and small enough not to be a nuisance when not in use, the Pittsburg Automatic Vise and Tool Company, Pittsburg, Penn., has brought out a new model which seems to fill the bill completely.

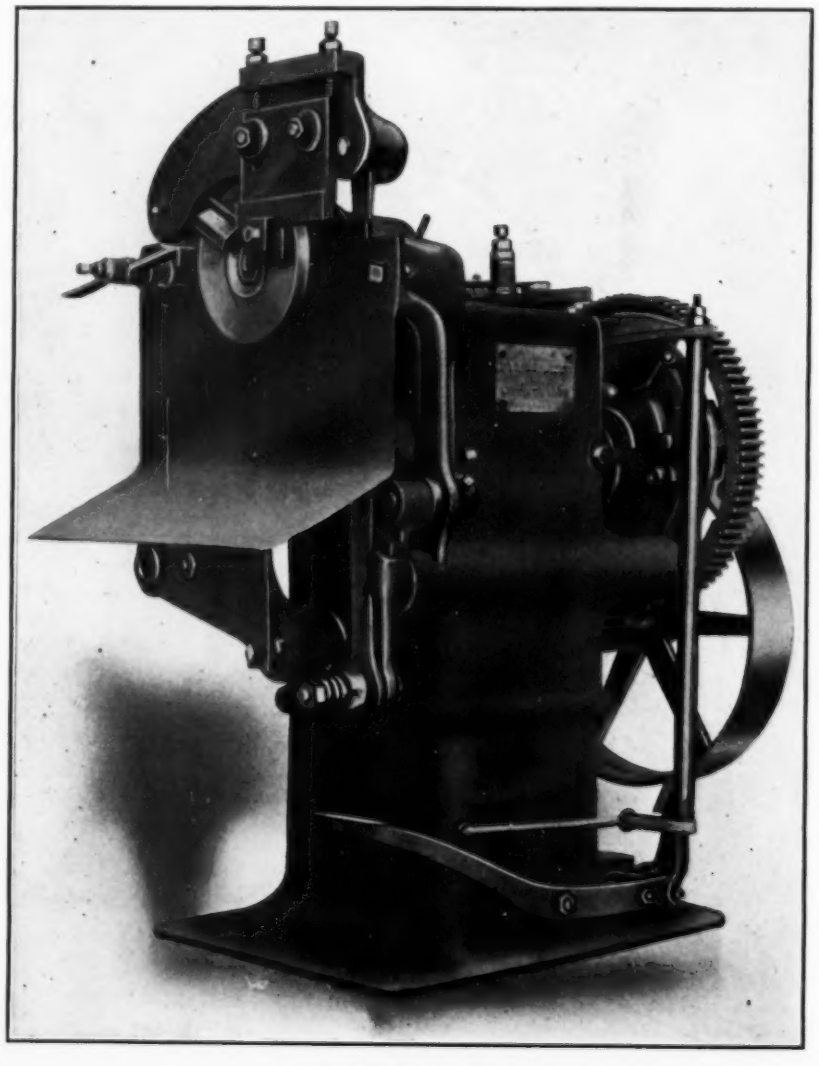
The illustration shows the method of construction. The base is 1¾ inches in diameter and is screwed to the running board of an automobile or attached to any place desired. The vise is kept in the tool box until needed and only needs to be set into place, as the tightening of the vise on the work clamps the vise firmly in the base.

This allows the vise to be turned at any desired angle, and the vise jaws themselves can also be swung around the screw to any position wanted, the clamping of the work also tightening this at the same time.

The parts subjected to stress are made of alloy steel, while the screw is a forging. This reduces the weight of the vise with 1¾-inch jaws to 3½ pounds. Extra bases can be attached to any place desired, so that the same vise becomes available at various parts of the shop, on a car or in a boat. They are finished either in nickel or aluminum.

Eye-bender

The eye-bender shown in the accompanying half-tone will handle stock of all shapes, up to and including one-inch round rod; it will work cold stock, and will bend and weld at one heat. It is used in implement, car, wagon, saddlery, hardware, bolt and nut and similar shops. The dies are simple, rough cast-iron pieces, weighing about three pounds for ordinary eyes; loops, angles and many other forms are bent on this machine at the rate of 12,000 pieces per day, a yearly average being 8000 pieces per day. It is furnished with a counter-shaft and is driven by a two-inch belt controlled by a shifter; it also has a stop motion with pedal to start; the machine stops ready to receive the stock, but the pedal may be set for the machine to run continuously if desired. The Lynch eye-bender is made by Williams Brothers, Cordova, Illinois.



EYE-BENDING MACHINE

Spring Winder

The tool shown herewith may be used with lathe, drill or vise for winding compression and extension springs of any length from wire of various thicknesses, the small sized tool winding up to 3/16-inch wire, and the large sized up to ⅜-inch wire. In using it the spacing washer is turned so as to bring a web of the desired thickness opposite the handle, the spring wire is passed through the hole in

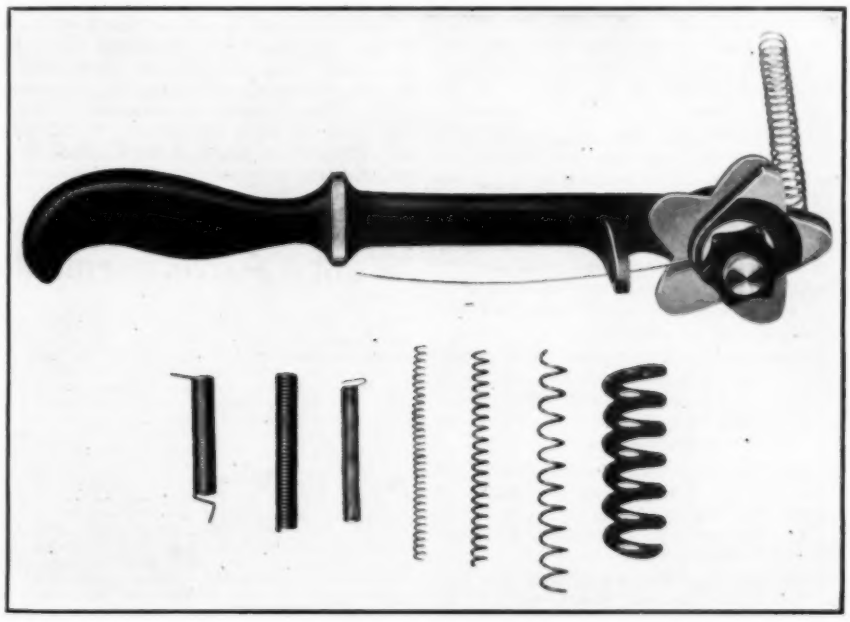
the lug cast on the handle and then between the friction washers and through the hole in the stud, and the end fastened on the arbor. The tool is made by the Remington Tool and Machine Company, Boston, Mass.

Boring Jigs without Laying Them Out

EDITORIAL CORRESPONDENCE

Our title may savor of the unusual, yet a method in use in the tool-making department of the Westinghouse Electric and Manufacturing Company, at East Pittsburg, Pennsylvania, brings about the boring of jigs without laying them out in the ordinary meaning of that term.

The machine tool used is a vertical-spindle milling machine with special attachments. The vertical spindle is provided with a power feed. For both the longitudinal and transverse motions of the table there are arranged graduated vernier scales with magnifying glasses so that the motion of the table in either direction can be controlled and measured from a given setting with whatever degree of accuracy is required.



SPRING WINDER

In boring a jig, it is first fixed in position on the table, and squared with the motions thereof as may be necessary for its character. From this original position it is an easy matter to move it in either direction any given distance as called for by the drawing. After one hole has been bored, it can be located for another hole in the same way, all measurements being made by means of the vernier scales which determine the motion of the table. The drawings for jigs to be bored on this machine are laid out with their dimensions at right angles with green working lines so that the drawing dimensions become vernier measurements when taken on the milling machine. It is thus an easy matter to start from the given working surface of a jig, bore the first hole, then a second, then a third and so on until the jig is fully bored, without having previously laid it out or taken any measurements upon the jig itself. The ease and accuracy of the method are apparent.

L. P. A.

Personal

H. M. Beugler, formerly superintendent of railways for Ford Bacon & Davis, operating department, operating the Newman properties in Houston, Texas, Memphis, Little Rock, Birmingham, Nashville, Knoxville, has taken a position with Dodge & Day, of Philadelphia and New York.

In far-off Medicine Hat, Alberta, Canada, where gasolene costs about 50 cents a gallon, and natural gas about 15 cents a thousand, some experiments in using the latter fuel in automobiles have been made by Dr. Charles F. Smith. A runabout upon which a tank 15x28 in. was mounted and charged with gas at 5 or 6 atmospheres, ran a few miles at a fuel cost of 1/20 cent per mile.

Business Items

Otto Dieckmann, Jr., has been appointed manager of the St. Louis sales office of Atlas Engine Works, builders of steam engines and boilers, Indianapolis.

The United States Metallic Packing Company, Philadelphia, has fitted up an automatic department for the manufacture of small duplicate parts.

The Nagle Engineering and Machine Works, Philadelphia, has purchased the real estate, equipment and good will of the Corliss Engine Works, Philadelphia.

Tate, Jones & Co., Pittsburg, Penn., has received a contract from the Seaboard Air Line Railway for the oil-burning furnaces for its new shops at Jacksonville, Fla.

The Perkins Manufacturing Company, Springfield, Mass., advises us that it has installed a gear department and is now prepared to cut all kinds of gears, racks, pinions, etc.

The Phœnix Iron Works Corporation, manufacturer of presses and special machinery, and the Fenn Machine Company, maker of drilling machines, have consolidated and will conduct business under the name of Taylor & Fenn Machine Company. The capital of the new corporation is $100,000.

Robert W. Hunt & Co., 1121 Rookery building, Chicago, have been given the inspection of the material for the Southern Pacific Company's rifled pipe line. This embraces 256 miles of 8-inch rifled pipe, which is being manufactured at the Lorain plant of the National Tube Company, and the machinery for 24 pumping stations, covering 46 duplicate pumps to be manufactured by the Jeanesville Iron Works, Hazleton, Penn., and 72 boilers to be furnished by the Edge Moor Iron Company, Edge Moor, Del.

Trade Catalogs

E. W. Bliss Company, Brooklyn, N. Y. Catalog of drop forging machinery. Illustrated, 30 pages, 5x7½ inches, paper.

Wm. J. Smith Company, New Haven, Conn. Pamphlet describing one-lock adjustable reamer. Illustrated, 8 pages, 6x9 inches.

The Bigelow Company, New Haven, Conn. Catalog describing the Bigelow-Hornsby water tube boiler. Illustrated, 9½x12 inches, paper.

Westinghouse Lamp Company, 512-534 West Twenty-Third street, New York. Catalog of incandescent lamps. Illustrated, 36 pages, 5x7½ inches, paper.

The Bristol Company, Waterbury, Conn. Pamphlet entitled "Plant Economy" by H. P. Dennis, M. E. containing illustrations showing records of Bristol recording instruments. 8 pages, 6x6½ inches, paper.

The D. T. Williams Valve Company, Cincinnati, Ohio. 1907 catalog and price list of engineering appliances, consisting of brass and iron valves, gauge-cocks, fittings, oil and grease cups, lubricators, steam traps, etc. Illustrated, 164 pages, 5x7 inches, paper.

General Electric Company, Schenectady, N. Y. Bulletin No. 4504, illustrating and describing Tungsten lamp for street series lighting. 4 pages, 8x10½ inches. Bulletin No. 4506 illustrating and describing Edison gem filament 50 watt lamp. 8 pages, 8x10½ inches. Bulletin No. 4512 on manhole fuse boxes—types MD and Tailleur. Illustrated, 4 pages, 8x10½ inches. Bulletin No. 4516 describing MR circuit breakers. Illustrated, 4 pages, 8x10½ inches. Bulletin No. 4517, describing isolated plant switchboard panels with fuses. Illustrated, 8 pages, 8x10½ inches. Bulletin No. 4518, describing electric hoists. Illustrated, 20 pages, 8x10½ inches.

Manufacturers

Frank & Company, Davenport, Iowa, will erect a new foundry.

The Rome (N. Y.) Electric Company will erect a new wire mill.

The Standard Safe and Lock Company, Des Moines, Iowa, will erect a new plant.

The Shelby (Ala.) Iron Company will build a new furnace for making coke iron.

The Youngstown (Ohio) Foundry and Machine Company will enlarge the capacity of its plant.

T. E. King & Company, Sanford, N. C., manufacturers of metal roofing, will erect a new plant.

The city of Mt. Airy, Ga., is considering the construction of water works and electric light plant.

The Beatrice (Neb.) Iron Works has awarded contract for the construction of a new foundry.

The Monarch Valve and Manufacturing Company, Warren, Mass., will build a new iron foundry.

The plant of the American Scraper Company, Sidney, Ohio, was destroyed by fire. Loss $200,000.

The Washburn Wire Company, of Providence, R. I., will erect five new buildings at its Phillipsdale plant.

The Randleman (N. C.) Electric Railway and Light Company, has secured franchise and will erect a lighting plant.

The Christiansburg (Va.) Chilled Plow and Machine Company, will rebuild its plant recently burned at a loss of $15,000.

The city of Newnan, Ga., will expend $5000 in building and equipment of a power station. S. W. Allen, engineer in charge.

The R. Wallace & Sons Manufacturing Company, Wallingford, Conn., making silver and plated ware, is erecting a four-story addition.

The Automatic Air Compressor Company, of Bridgeport, Conn., has filed organization certificate. John Rogers, of Bridgeport, is president.

The Southern Car Manufacturing and Supply Company, of Beaumont, Texas, will move to Catttanooga, where a $100,000 plant will be erected.

The Wheeling Enameled Iron Company will double the capacity of its plant at Elm Grove, W. Va. A new foundry building will be erected.

The Memphis (Tenn.) Automobile Company has been incorporated with $50,000 capital stock by S. T. Carner, N. C. Perkins, W. B. Gates, etc.

The Standard Pipe Foundry Company, Columbic, S. C., is being organized to manufacture soil pipe and fittings. Address is 1416 Laurel street.

The Montgomery-Moore Manufacturing Company, Nashville, Tenn., will build a harness and leather goods factory, expending about $20,000.

The Crown Electrical Manufacturing Company, St. Charles, Ill., making chandeliers and brass goods, is erecting a new building, which will cost $10,000.

The Niagara Electro Chemical Company, Niagara Falls, N. Y., will erect a new addition, which will include a transformer room, at a cost of $35,000.

Contract has been awarded for a new building at the plant of the Turner Tannery Machinery Company, Peabody, Mass., to be used as a machine shop.

The Statesville (N. C.) Oil and Fertilizer Company will build a small shop to be equipped with lathe and other toools with which to do its own repairing.

The Columbus (Ohio) Bridge and Iron Company has purchased a factory building, which it is remodeling and fitting up for the manufacture of structural steel.

The calcining plant of the St. Joseph Lead Company, at Leadwood, Mo., was burned, causing a loss of several hundred thousand dollars. The plant will be rebuilt.

The Pittsburg (Penn.) Steel Company will erect eight 60-ton open hearth furnaces, a blooming mill and three billet mills at Monessen, expending about $4,000,000.

The Crown Manufacturing Company, North Attleboro, Mass., has been formed to manufacture metal novelties. Charles T. Page and Frank L. Baker will control the concern.

The Wallace Machinery Company, Champaign, Ill., is now being incorporated and a new plant for the manufacture of the Wallace Sprayer and other things will be erected.

The National Cement Company with offices at 1 Wall street, New York, which recently incorporated, intends to erect a mill for the manufacture of portland cement at Carpenterville, N. J.

The Ford Pump and Engine Company, is being organized in Spokane, Wash., for the purpose of manufacturing a new rotary engine and pump. Capital, $100,000. President, A. F. Ford.

Plans are being considered by the Gouder & Paeschke Company, Milwaukee, Wis., for an extensive addition to its plant. The company manufactures tinware, sheet and galvanized iron, etc.

The Wheeling (W. Va.) Automobile Company has been incorporated with $10,000 capital to manufacture and deal in automobiles. Incorporators, J. C. Stamp, A. A. Wheat and others.

The Louisville (Ky.) Automatic Smoke Preventing Company, has been incorporated to manufacture a smoke-preventing device. Capital $10,000. Incorporators, C. P. Frick, A. E. Mueller and H. P. Dean.

The Fay & Egan Company, Cincinnati, Ohio, builders of woodworking machinery, it is said, is planning the erection of a new plant which will include a foundry for the manufacture of its castings.

The Oakland (Cal.) Cotton Mills Company has been organized with a capital stock of $500,000. A large plant will be erected for the production of twine, batting, rope, etc. L. C. Morehouse is president.

Harry Bros. Company, Dallas, Texas, has been incorporated with $150,000 capital to manufacture cisterns and tanks. T. C. Harry, W. W. Chandler and others, incorporators. Address is 235 Alamo street.

Plans have been completed for a new factory for Robert Reiner, Weehawken, N. J., manufacturer of embroidery machinery. This will be equipped with the latest improvements and cost $40,000.

The Baton Rouge (La.) Manufacturing Company is being organized to operate a woodworking plant for the production of sash, doors, blinds, etc. Capital $40,000. F. M. Walker, Atlanta, Ga., manager.

The Simplex Cigarette Packer Company has been organized at Baltimore, Md., to manufacture machines for packing cigarettes; capital $200,000; incorporators, R. V. Craggs, J. E. Allemong, N. P. Allemong, etc.

The Conley Frog and Switch Company, Memphis, Tenn, incorporated with $200,000 capital stock, has secured a site on which a plant will be erected. This will be operated by electricity. J. E. Conley is president.

The Straight Line Engine Company, Syracuse, N. Y., will make extensive improvements, among which will be an addition to the machine shop, an electrical crane and additional equipment in the power house.

The Sanitary Paper Milk Bottle Company, St. Louis, Mo., has been incorporated to manufacture bottles and other articles from paper. Capital $100,000. Incorporators, Durbin H. McClelland, Joseph Morrison, etc.

The Leamington Manufacturing and Construction Company, Pittsburg, Penn., has been organized to manufacture track-moving machines and other railway equipment. Capital, $100,000. Hon. R. H. Jackson is president.

The Lunkenheimer Company, Cincinnati, Ohio, will increase its capital stock to $2,000,000 and will make extensive improvements at its plant. A building will be erected for the manufacture of pressed steel window and door frames.

The Minnesota Steel Company has filed articles of incorporation. The capital stock is $10,000,000 and the incorporators are Thomas F. Cole, William J. Olcott, Frank E. House and Joseph B. Cotton, of Duluth. Large steel mils will be erected in Duluth.

The Cincinnati (Ohio) Iron and Steel Company has been incorporated for the purpose of erecting a rolling mill, which will employ 3000 hands it is said. Edward H. Busch, president of the Cincinnati Iron Store Company, is at the head of the company.

Extensive improvements are to be made to the plant of the Youngstown (Ohio) Sheet and Tube Company, on which, it is stated, $3,000,000 will be expended. These will include a new galvanizing plant, blast furnaces, addition to the machine shop and foundry, etc.

Application for a charter has been made by the Allegheny Valley Malleable Iron Company and work has already been started on the construction of a plant at Parnassus, Penn. The company is composed of Pittsburg and St. Louis capitalists. P. H. Murphy, Pittsburg manager of the Standard Railway Equipment Company of St. Louis, is at the head of the enterprise.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

Let us quote you on gear cutting. Iroquois Machine Co., Providence, R. I.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

We desire a few more machines or specialties to manufacture. Box 423, Troy, N. Y.

Machines designed and built. Walter S. McKinney, M. E., Broadway, Flushing, N. Y

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Can act as engineer and New York representative as side line. G. E. Hackett, M. E., 71 Nassau St., New York.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

We will do your manufacturing for you; well established and equipped foundry and machine shop. Emmert Mfg. Co., Waynesboro, Penn.

Well established concern will pay royalty for several good patented machines or tools to manufacture. Emmert Mfg. Co., Waynesboro, Penn.

A well equipped machine shop in New England of sufficient capacity to employ 200 men is in a position to take on more work. Box 186, AMERICAN MACHINIST.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Men who operate grinding machines would read H. Darbyshire's "Precision Grinding," a $2 book that's worth ten times that money to you. Hill Pub. Co., 505 Pearl St., New York.

A well equipped machine shop and foundry desires to add to its output by the manufacture of articles of brass and iron which would find a ready sale in the south; correspondence invited. Box 122, AMER. MACH.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th Street.

Advice; mechanical, practical and technical; tell me your needs I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

Arrange with us to do your manufacturing; we are thoroughly equipped for all classes of machine work, including screw machine and punch parts, tools, jigs, etc.; we also design and build to order special and experimental machinery. Forest City Specialty Manufacturing Co., Rockford, Illinois.

Planer—hands—C. Ashley, a planer hand, has written a book "Planer Kinks," for practical planer men and every planer hand should get it; $1 postpaid. Hill Pub. Co., 505 Pearl St., New York.

Wanted gas engines built; one of the largest and oldest gas engine firms—located west—desires to make contract with eastern manufacturer to build marine gas engines up to 16x18 multiple cylinder; patterns, drawings and initial supervision furnished; must have capacity for $250,000 to $350,000 annually. Box 207, AMERICAN MACHINIST.

We have a special proposition for a few bright, energetic mechanics, such as foremen, draftsmen or machinists in different sections of the country; no canvassing or selling of any kind, and, while not interfering with your regular work, pays well for the time taken; we want only practical men who can be depended on to give the little time required each week; further particulars on application. Box 102, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Superintendent or master mechanic with 20 years' of practical experience, in both mechanical and electrical manufacturing, who is well informed on up to date tools, fixtures and general equipment, etc., for duplicate and interchangeable manufacturing. Address "Superintendent," 136 Myrtle Ave., Stamford, Conn.

ILLINOIS

Responsible shop position on steam turbine work; several years' experience in America and England. Box 212, AMER. MACHINIST.

Superintendent, practical machinist and toolmaker; wide experience on interchangeable work, special machinery and metal specialties; excellent manager of men; can handle big proposition and produce results; high recommendations. Address Box 143, AM. M.

MASSACHUSETTS

General foreman, now employed on automobile construction, desires to make change; long experience, best references; can show results; Massachusetts preferred. Box 205, AMERICAN MACHINIST.

NEW JERSEY

General foreman, excellent toolmaker and machinist, designer of labor-saving devices, open for engagement. Box 224, AM. MACH.

NEW YORK

Draftsman, experienced, seeks position. Box 213, AMERICAN MACHINIST.

Mechanical draftsman wishes position. Address Box 201, AMERICAN MACHINIST.

Draftsman, 8 years' experience steam pump, and engines, seeks position. Box 223, AM. M.

Draftsman, 5 years' experience, also experienced in shop work wishes position in vicinity of New York. Box 225, AMER. MACH.

Wanted—A position as chief engineer, mechanical and electrical; can furnish the best of references by inquiries. Box 183, AM. M.

Draftsman. 7 years' experience on automatic and general machinery wishes permanent position, would like to take charge of small drafting room. Box 229, AMER. MACH.

Experienced designer, 10 years' of automatic machinery, presses, shears, tools, gas engines, German University graduate with executive ability; salary $24 week. Box 208, AMERICAN MACHINIST.

General superintendent; high class, hustling, aggressive, energetic, economical; can crowd the work out and deliver the goods, meet competition in highly competitive lines, close at rating and estimating, designing tools, dies, machinery in any line of manufacture; never failed to surpass all expectation in making good my representations. Address "Mechanical Engineer," AMER. MACH.

OHIO

Chief draftsman machine tools wants change; technical graduate; 32 years and married; A-1 references. Box 215, AM. M.

Wanted—To represent some reliable concern in Cincinnati territory by young man; technical and ten years' practical experience in machinery line. Box 209, AMER. MACH.

PENNSYLVANIA

Foreman desires charge of machine shop or department; Philadelphia or vicinity. Box 226, AMERICAN MACHINIST.

Foreman or assistant superintendent experienced on valves and fittings, machine tools, engine parts and general repair; references furnished; salary about $1500. Box 185, AMERICAN MACHINIST.

Experienced organizer, tool and jig designer, familiar with latest shop and office methods, ball-bearing and screw machine work details; want position as manager or superintendent. Box 216, AMER. MACHINIST.

Wanted—Position as advertising manager with manufacturing concern, preferably in mechanical field, by a woman with years of experience in that capacity and field, with large, representative houses; thoroughly competent to handle printing, illustrating and the preparation of copy; at present employed; reasons for seeking change made known to prospective employer. Box 103, AMERICAN MACHINIST.

VERMONT

Advertiser will be open for engagement as works manager or mechanical engineer on September 1. Address Box 170, AM. MACH.

WISCONSIN

Mechanical engineer and draftsman; 29 years old, married, with 5 years' experience in boilers, steam turbines, water turbines and governors, as well as shop experience wishes position. Box 211, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Toolmakers experienced on fixtures, dies and gages. Address with full particulars as to experience, wages required, giving definite time as to commencing work. Ross Rifle Company, Quebec, Canada.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—Mechanical foremen desiring good positions with large manufacturing company, can secure same by investing from $1000 to $5000 in stocks paying 14 per cent. dividends; permanent foremen are the objects. Write quickly to P. O. Box 725, Bridgeport, Conn.

FLORIDA

Wanted—Coppersmiths, $2.80 to $4.00 per diem. Apply to Board of Labor Employment, Navy Yard, Pensacola, Fla.

ILLINOIS

Wanted—First-class salesman for high speed tools; must be practical man, capable of demonstrating tools in shops, factories, etc. Box 210, AMERICAN MACHINIST.

Wanted—Automobile engineer and designer competent to take charge of designing and developing a high-grade four-cylinder runabout; only a man of unquestioned ability and experience will be considered. In reply give age, experience and state salary required. Box 220, AMERICAN MACHINIST.

INDIANA

Wanted—Five good toolmakers and six lathe men; good wages; steady employment. The Western Motor Co., Logansport, Ind.

MASSACHUSETTS

Wanted—First-class machinist in large manufacturing concern; steady work; no labor troubles. Box 221, AMER. MACHINIST.

Wanted—Bright young man with experience running Acme automatics; steady work, no labor troubles. Box 222, AMER. MACH.

First-class draftsmen and tracers; good checkers and men with experience in designing small and medium size machine tools preferred; location, vicinity of Boston. Box 228, AMERICAN MACHINIST.

Wanted—Man thoroughly familiar with the manufacture and assembling of small machine parts to act in the manufacturing department as assistant to the superintendent. Boston Gear Works, Norfolk Downs, Mass.

MINNESOTA

Wanted—First-class machinists on lathes, planers, floor and vise work; non union men only; yearly contracts at 30c. and 40c. an hour. Diamond Iron Works, Minneapolis, Minn.

MISSOURI

Few first-class die makers, highest wages, open shop; references required. Box 214, AMERICAN MACHINIST.

Draftsman wanted—Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 867, AMERICAN MACHINIST.

NEW JERSEY

We have increased our plant and desire floor and vise hands for [illegible] work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Mechanics or brass workers with experience at instrument making preferred; good pay and prospects for advancement to capable men in Newark; state experience, age and wages expected. Box 206, AMER. MACH.

NEW YORK

Wanted—First-class toolmakers on tools, jigs, and fixtures. Boxes 7 and 8, Syracuse, N. Y.

Wanted—Draftsman, experienced in machine equipment; in replying state age, married or single, if now employed, experience and wages expected. Box 218, AMER. MACH.

Wanted—Assistant machine shop foreman familiar with latest methods of reduction, valves and fittings; must have good executive ability to get out work quickly; permanent position for right man. Box 219, AM MACH.

Mechanical engineer with about one year's experience in mill or factory and maintenance work; must be a technical graduate; excellent oportunity for the man who can get things done. Write, stating age, experience and salary expected. Adress "J. W.," 41 W. 34th St.

Toolmaker; a first-class practical toolmaker, familiar with all kinds of tool work and shop practice; experienced in handling men; a good position for the right man; write, stating age, experience both as a mechanic and in handling men, and salary expected. Address "Tools," 41 W. 34th St., New York.

Ambitious and thoroughly competent machinist with some general knowledge of drafting and designing wanted by a concern in Brooklyn, N. Y. Opportunity of advancement to charge of department open to accepted applicant; write stating shop experience, terms, etc. Address "Camachine," care AMERICAN MACHINIST.

Machinist foreman; high grade man who has held executive position for some years with successful jobbing or general machinery concern operated under advanced methods and who is looking for financial advancement; applicant must be good designer; capable manager and have had wide mechanical experience; department can employ 30 to 40 men, is now making special machinery under contract also is taking up own line; good salary with further prospects for a successful and satisfactory man. Address "Tracto," Box 227, AMERICAN MACHINIST.

OHIO

Wanted—Experienced punch and shear draftsman; state qualifications, age, and salary expected. Box 70, AMER. MACHINIST.

Wanted—Several draftsmen familiar with steam hammer designing; state age, experience, and salary expected. Box 71, AM. M.

Wanted—Machinists and operatives; we are about to remove our machine shops from Kent, Ohio, to Franklin, Pa. Some of our present employees own their homes in Ohio and do not wish to leave them so are seeking other permanent employment here. We therefore offer to qualified persons positions in our present plant from now until about October first and permanent positions to those who then move with the plant to Franklin, Pa. To such persons who accept service with us under the present conditions, we will guarantee the best permanent positions when our Franklin plant is in operation, giving the preference even over present residents of

Franklin. Franklin is a beautiful little city of 12,000 inhabitants with excellent schools and other facilities. We have no labor troubles in our shops nor have we ever had any. Address communications to C. L. Winey, Works Manager, Kent, Ohio.

PENNSYLVANIA

Wanted—Lathe, planer and boring mill hands. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Foreman for gear cutting department; must have experience; apply with particulars to R. D. Nuttall Co., Pittsburg, Pa.

We are just completing the fitting up of a modern machine manufacturing plant, and invite applications for employment from machinists, pattern makers and molders; steady employment and good wages for reliable and desirable workmen; when writing give full details of experience. The Shepherd Engineering Co., Williamsport, Pa.

First class molder with experience on medium weight high grade iron machinery castings; to the right man if familiar with melting iron, and with ability to handle men, position of assistant foreman is open; to receive consideration give full details of experience, for whom you have worked, length of time, class of work, and wages received. All communications will be considered confidential. Box 217, AMERICAN MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

WISCONSIN

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

Automatic drill chuck, patent, the greatest time saver of the day. Address "Ed. Blaess, care Henry F. Setzler, Fremont, Ohio.

For Sale or will lease to responsible parties modern equipped brass foundry, located in Brooklyn. Address "B. F.," AMER. MACH.

For Sale—Ten volume library covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

One 10x10x12 duplex steam pump; one 10x14x12 Rand air compressor; one No. 3 Toledo punch press; two hydraulic presses, will take in material 35"x35". Shartle Brothers, Middletown, O.

For Sale—An established and very profitable manufacturing plant employing about 60 men making iron working machinery and tools; the business has grown about 50 per cent. each year, and offers exceptional opportunities for greater increase in the future; good reasons for selling. Address "Manufacturer," AMERICAN MACHINIST.

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Cortland Cor. Wheel Co., Cortland, N. Y.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

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Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
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Butterfield & Co., Derby Line, Vt.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arches, Boiler Door

McLeod & Henry Co., Troy, N. Y.

Architects

Dodge & Day, Philadelphia, Pa.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, Ohio.
Kilbourne & Jacobs Mfg. Co., Columbus, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Baird Machine Co., Oakville, Ct.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
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Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
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Shultz Belting Co., St. Louis, Mo.

Belt Filler

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belting, Leather

Main Belting Co., Phila., Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
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Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chain

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Blowers

American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.
Keuffel & Esser Co., New York.
Soltmann, E. G., New York.

Blue Print Paper

Keuffel & Esser Co., New York.
Soltmann, E. G., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Boiler Setting

McLeod & Henry Co., Troy, N. Y.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
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Brown Co., H. B., East Hampton, Conn.
Detrick & Harvey Mach. Co., Baltimore, Md.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Corespondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Philadelphia, Pa.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Horseless Age, New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadephia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction

Electric Controller & Supply Co., Cleveland, O.

Brazing

Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum

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Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing

Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze

Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Manufacturers Foundry Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel

Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.
Keystone Steel Casting Co., Chester, Pa.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.

Centering Machines—*Cont.*

Hill, Clarke & Co., Inc., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor, Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer

Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co, New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Woods Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic

Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic

Sturtevant Co., B. F., Hyde Park, Mass.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Slushing

Warren Bros. Co., Boston, Mass.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas

Ingersoll-Rand Co, New York.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts

National Brake & Clutch Co., Boston, Mass.

Corundum

See Grinding Wheels.

Cotters

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Heber & Co., J. R., Brooklyn, N.Y.
Veeder Mfg. Co., Hartford, Ct.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Electric Controller & Supply Co., Cleveland, Ohio.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes,

Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

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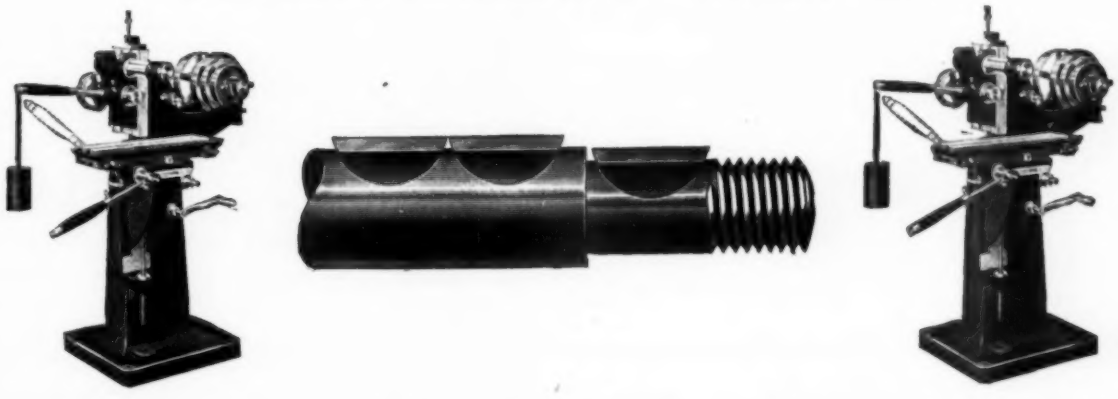


THE WHITNEY MFG. COMPANY

HARTFORD, CONN.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Phila., Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros. Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cu...ng-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.

Cyclometers
Veeder Mfg. Co., Hartford, Ct.

Diamond, Tools
American Emery Wheel Co., Providence, R. I.

Diamond, Tools—*Continued.*
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, Ohio..

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.

Dies, Sub-Press
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Noyes Mfg. Co., Waynesboro, Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, Ohio
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.

Drilling Machines, Multiple Spindle—*Continued.*
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Mach. Co., Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, Ohio.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.

Drilling Machines, Upright—*Continued.*
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Mach. Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Coates Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Dallett Co., Thos., H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Eectrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

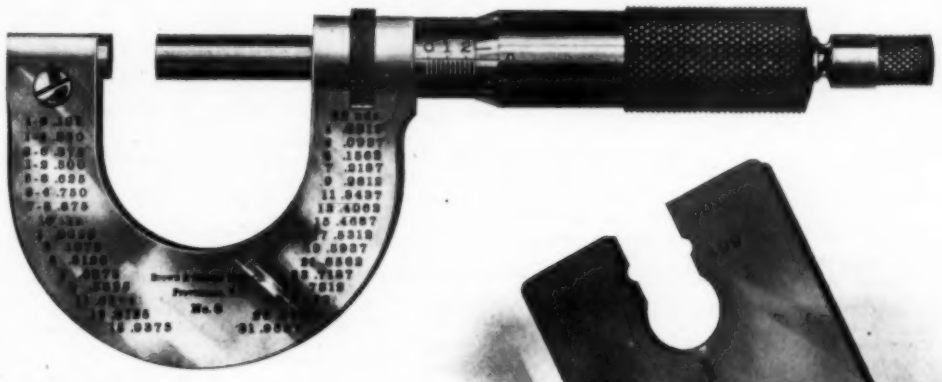
DriHs, Rock
Ingersoll-Rand Co., New York.
Northern Eectric Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Clark, Jr. & Co., Jas., Louisville, Ky.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.



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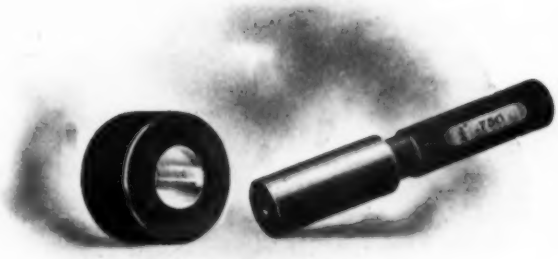

Brown & Sharpe Mfg. Company,
Providence, R. I., U.S.A.

B&S Mfg.Co.

Electrical Supplies—*Cont'd.*
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr. & Co., Jas., Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Mechanical and Electrical
Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Philadelphia, Pa.
Merritt, Jos., Hartford, Conn.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.

Engines, Steam
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers
Bormay Engraving Co., New York.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Philadelphia Bourse, Phila, Pa.

Expanders, Tube
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment
Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps
American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York.

Filler, Iron
Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.
Simplex Mfg. Co., New York.

Fire Brick
McLeod & Henry Co., Troy, N. Y.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co, Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery
Scranton Co., The, New Haven, Conn.

Forgings, Drop
Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic
Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine
Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel
Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Crescent Forgings Co., Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Smith Fdry. & Supply Co., J. D., Cleveland, O.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gas Blowers and Exhausters
Sturtevant Co., B. F., Hyde Park, Mass.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.

Gear Cutting Machinery—*Continued.*
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide
Boston Gear Works, Norfolk, Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.